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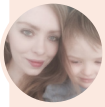
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ABC Certified Average Net Circulation of 9,566 for the period of 01/07/15 to 30/06/16.

editor's letter

ISSUE 21

Welcome to the new and – we hope you'll agree – improved Passive House Plus. We've made some substantial changes to the magazine's design, layout and content, for a very specific reason: to be as engaging as possible, but without dumbing down. Passive House Plus was and will remain a technical magazine focused on how and why to build ultra low energy, comfortable, healthy, robust, low environmental impact buildings. These concerns have moved from the margins now – they're no longer the sole preserve of a subset of early adopters. It's incumbent on us to respond by writing about sustainable building in the most accessible way we can. Even readers with the most sophisticated knowledge of the intricacies of sustainable building stand to benefit from this process. After all, the whole industry needs to learn how to describe sustainable building better, to make something seemingly complex explicable; to make something worthy desirable.

The first thing that may have struck you is our new masthead, which has changed in both typeface and content. We remain Passive House Plus, but our new subheading – Sustainable Building – is also a prominent part of our visual identity. The point is that our focus extends beyond the concerns of passive house, towards sustainable building in the round. We agonised over different subheadings: nearly zero energy building (very topical, but too long, jargony and niche), zero energy building (too energy focused, and arguably a theoretical impossibility), and evidence-based building (too long, and too sciencey, as if that's a bad thing) among others. In the end nothing spoke more of the breadth of issues that concern us than 'sustainable building'. Passive house will always be a major part of what we do. The reality is that there are right and wrong ways to approach sustainable building. Nothing sums up so many of the key principles better or more clearly than passive house – carefully planned design and construction, consideration of form, orientation and layout, an emphasis on airtight, highly insulated, cold bridge-free fabric, and a ventilation system that actually works.

We've also introduced some new sections, and reshuffled the order. The expanded contents section overleaf will guide you through. International, a pictorial feature on some of the best examples of beautiful sustainable buildings the world has to offer, is now before news. That's followed by a short, sharp news section, as we've separated news in two, creating a new section deeper into the magazine called Marketplace, which includes news on some of the latest product and service innovations from some of the leading names in the sustainable building sector.

And we've combined new build and retrofit into a single case studies section, which features a mix of some extraordinary exemplar projects from Ireland and the UK. We believe our new design has enhanced these articles too: we're giving case studies more space, to make them easier on the eye. New key facts panels at the start of each article provide a simple overview of each building, while the forensic detail on build specs is listed at the tail end.

Finally, we've introduced a new kind of technical reference article, 'The Ph+ Guide to…' We kick off this issue with a guide to external insulation, including an overview of why external insulation can be such a compelling option, and the issues to watch out for to ensure a successful application.

We'd love to hear your thoughts on the new design. Here's hoping it helps inspire and inform you to design and build the kind of delightful, sustainable buildings the world needs now more than ever.

Regards,
The editor

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About
Passive House Plus is an official partner magazine of The Association for Environment Conscious Building, The International Passive House Assocation and The Passivehaus Trust.

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Policy for zero, or zero policy?

The penny is starting to drop that profound energy saving efforts in buildings – right up to zero emissions levels – are both necessary and urgent if the UK is to honour its climate change targets. So what's holding up meaningful action, asks Peter Rickaby?

Recently I was invited to a seminar about emissions from UK buildings, by the Government Office for Science and the UK Energy Research Centre. Although unable to attend, I was prompted to martial my thoughts on the topic. Earlier, a civil servant from the UK Department for Business, Energy and Industrial Strategy (BEIS) told me that all their UK emissions models suggest that if we are to meet our targets then emissions from buildings must be reduced to zero. This begs the question: where is the policy to deliver that? Perhaps that is the policy?

Reducing the energy demand of all buildings to zero by 2050 is not a realistic prospect. However, reducing emissions to zero by a combination of nearly zero energy buildings (nZEBs) and zero supply side emissions looks possible. Renewable energy feeding the grid, on-site renewables and new battery technologies in buildings might do it. But how are we doing with nZEBs?

In the new-build sector, we know how to design and build nZEBs. The variety of certified passive houses shows how, and we are starting to deliver certified housing. In the non-domestic sector, examples such as the UEA Enterprise Centre and the Leicester University Medical Centre demonstrate what an nZEB looks like. The problem is scaling-up: the passive house standard is robust but voluntary, but UK regulatory standards are inadequate and poorly enforced. We need initiatives like those in Ireland, such as Dún Laoghaire-Rathdown County Council's passive house policy. Ireland is pushing towards nZEBs, but the UK political imperative is to build as many new homes as possible, quickly. We don't seem to have noticed that building lots of new homes badly, to inadequate standards, makes the emissions problem worse, not better.

We also don't seem to have noticed that most UK house-builders are part of the problem, not part of the solution. They fight against any new standard, and when standards are imposed they find shoddy ways of meeting them, or cheat. The enthusiastic uptake of decentralised mechanical extract ventilation that cannot deliver ventilation compliant with building regulations is a good example. Another is the response to the revelation that new homes are overheating: a call for regulation so house-builders can claim compliance and limit their liability. What about improving the product? A recent visit to a Cairn Homes development near Dublin opened my eyes to the quality that house-builders can achieve, if they are committed to high standards. The problem in the UK is that house-builders make their money from the increment in land value, not from the quality of what they build, and in the current market they can sell anything, however poor. We must change that.

Unfortunately, in any year only 0.3% of domestic emissions are associated with homes built that year: the other 99.7% come from homes built in previous years. Over 80% of the buildings around us will still be standing in 2050. Thus the focus of the emissions challenge is not new build but retrofit: in the UK there are around twenty million homes and two million non-domestic buildings to improve.

Again, we know how to deliver one-off deep retrofit. There are many examples of homes retrofitted to the Enerphit standard, or similar. The professional community around the Passivhaus Trust, the AECB and the Retrofit Academy has accumulated much knowledge. We know that reducing emissions on site by 60% (at current emissions factors) is achievable, 80% is challenging, and 100% is almost impossible, so the supply side has a role to play. We know that the average cost of reducing emissions by 80% is £90,000 per dwelling one-off and probably £50,000 at scale. We know that the cost of reducing emissions by 60% is £45,000 one-off and around £25,000 at scale. So in the UK, with twenty million homes to improve, we must spend £500 billion. Depending on whether you are a glass half empty or a glass half full person, that is either a big challenge or a big business opportunity.

> The average cost of reducing emissions by 60% per dwelling is £45,000 one-off and around £25,000 at scale. So in the UK, with twenty million homes to improve, we must spend £500 billion.

Can we deliver deep retrofit at scale? In the domestic sector, owner-occupiers have little incentive or resource, and many households are struggling with fuel poverty. People in cold, mouldy homes are uninterested in reducing emissions, so we must deal with fuel poverty first. Then for retrofit we need: comprehensive technical standards, guidance and training; quality assurance (with teeth) to provide consumer confidence; retrofit incentives; and subsidies for those unable to pay.

Then there are some technical aspects of retrofit that we could improve. Our understanding of moisture management is growing, through the work of the UK Centre for Moisture in Buildings, but complex information must be distilled into simple guidance. Ventilation must become central to our retrofit strategies; demand controlled ventilation is leading the way, but we need more options. Risk management is emerging as a retrofit discipline, and the Retrofit Academy is training more retrofit coordinators for this role.

Finally, one issue will come back to bite us in new-build and retrofit: overheating. If we don't take overheating seriously, and get to grips with it, then hot homeowners will buy portable air conditioners and there will be no emissions saving.

Some policy would help too. ■

Peter Rickaby is director of Rickaby Thompson Associates, a trustee of the National Energy Foundation, a member of the implementation board of the Each Home Counts (Bonfield) review, and chairs the BSI Retrofit Standards task group.

The views expressed here are his own.

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MARLY HOUSE, MARLY-LE-ROI, PARIS

On a tree-lined street in Marly-le-Roi, a small community outside Paris where properties are typically isolated by fencing that's mandatory under local planning rules, one house reaches out to its neighbours.

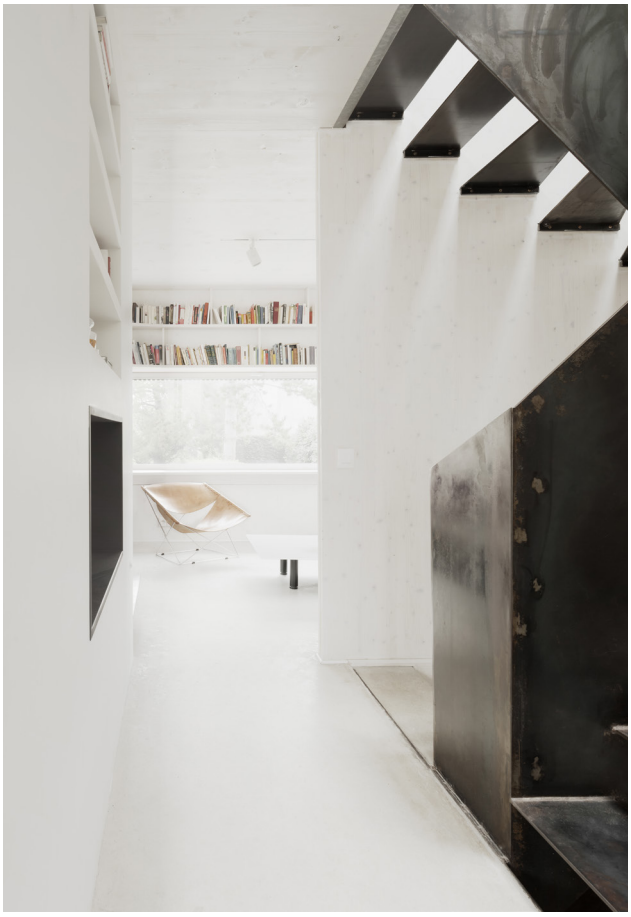
Designed by Karawitz Architects, Marly House has perforated fencing that allows passers-by to see into the garden, which actually runs under the house, so that the dwelling appears to levitate above its plot. Firewood storage and parking are provided in the space underneath. Meanwhile a large terrace is cantilevered out onto the street, helping to blur the boundary between private and public.

And even though it isn't passive certified, the architects — who built France's first passive house in 2009 – still built the dwelling to the standard, and insulated the building's timber frame with recycled newspaper and woodfibre. And this is no ordinary timber frame building – it's a prefabricated cross-laminated timber (CLT) build, an ecological innovation which is redefining the boundaries of timber engineering.

Inside, the ground floor features three fluid spaces organised around a central stove — the house's only heat source. The kitchen and living room sit either side of the steel staircase, cut from a single piece of steel, while two steps above this the terrace reaches out onto the street.

Upstairs, high-level windows look skyward, protecting the privacy of the house's occupants. Meanwhile raw materials like steel and concrete are left exposed to "create a sense of authenticity," say the architects. From the pre-grayed larch cladding to the fold of the main facade, they say that "everything is a pretext to awaken the curiosity of passers-by".

Photos: Schnepp Renoud | Location: France



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GUILFORD SOUND ARTIST'S RESIDENCE, VERMONT

The Guilford Sound recording and production campus in Southern Vermont serves as a creative site for local and visiting artists to develop and record music and other sound-based projects.

Designed by Ryall Porter Sheridan Architects, this stunning new five-bedroom, passive house certified residence allows recording artists to live on the campus, within walking distance of the recording studio.

The building is embedded in a gently sloping, south-facing hillside with views of the Ashworth Valley and the distant foothills of the Green Mountains. A fully vegetated roof flows seamlessly into adjacent field grasses. An exterior stairs, open to the sky, slices through the building, encouraging residents to walk up and explore the upper reaches of the site.

The architects say it was "important to respect the natural beauty of the countryside, and make the artists' residence a part of the landscape."

Clad entirely in steel plate rain-screen, sandblasted and left to oxidize naturally on site, the exterior has a variegated appearance of different colours and textures.

Inside, the sleeping rooms are connected by a single hallway illuminated by a clerestory window above, and by a backlit chalkboard designed to be used as a tool for collaboration.

Meanwhile the airtight timber-frame structure is insulated with cellulose, which offers thermal mass and humidity buffering, and features such as the steel frame and concrete staircase were naturally designed to be free of thermal bridges. The result is a building that effectively and efficiently meets the heating demands of even the coldest Vermont winters.

INTERNATIONAL

Photos: Ryall Porter Sheridan Architects | Location: United States

NEWS

The latest on passive house, eco-building and construction, including news on nearly zero energy building (nZEB) standards, building regulations, and some exciting new low energy building projects.

13 affordable passive homes completed in Crawley, West Sussex

Gales Place consists of 13 new affordable homes – six flats and seven houses.

Crawley Borough Council's first passive house development, designed by Accredited Passivhaus Design (APD), has been completed and certified to the passive house standard.

Gales Place in Three Bridges provides 13 new affordable homes, six flats and seven houses, for local residents. Each property is heated by just one radiator and two towel rails.

The development is located on a complex site and provides a new urban space next to an existing community centre, safe routes to the adjacent primary school, and car parking for residents and other local people.

Heating bills for a typical two-bedroom house at the development are predicted to be about £15 per month, or less than 50p per day.

APD's certified passive house designer Peter Ranken said: "As council housing is provided for people in housing need, the low energy use of these passive house homes will make a strong contribution to reducing fuel poverty. Also, the good construction quality of these dwellings will ensure durability and comfort for the future."

Councillor Stephen Joyce, Crawley's cabinet member for housing, said: "This is a brilliant development that not only provides high quality housing, but also lowers energy bills and has less of an environmental impact. I am so pleased that we have these to offer our tenants and I hope that we are able to offer more passive house homes in the future."

Accredited Passivhaus Design has been appointed to design Crawley Borough Council's second passive house project, Dobbins Place, a development of four houses and two flats in Ifield, Crawley. ■

No shortage of funds for energy renovation, EU debate hears

At a recent breakfast debate hosted in the European Parliament, the European Council for an Energy Efficient Economy (ECEEE) joined industry group Renovate Europe, along with MEPs, commission officials and the banking sector to discuss the economic case for building renovation to meet the commission's goal to bring the European building stock up to nearly zero energy building (nZEB) levels by 2050.

"Banks are ready, willing and capable to meet the demand for energy renovation when it materialises. There is no shortage of funds — we have all the tools ready to be deployed. But confidence must be boosted in the market," said Stephen Hibbert from ING bank, speaking at the event. "Increased awareness and a stronger legislative and policy framework, with ambitious, bold and binding measures, can act as important triggers to stimulate consumer demand for energy renovation."

MEP Bendt Bendtsen, rapporteur on the Energy Performance of Buildings Directive (EPBD), backed up this view, adding: "Private investment is ready, be it the commercial banks like ING taking up the upfront investment, or be it institutional banking like pension funds securing the long-term income stream, both want to invest in energy renovation. A strong EPBD must support this private investment."

The current revision of the EPBD offers a window of opportunity to address the demand for building renovation by boosting confidence and providing the regulatory certainty both for investors and for consumers.

Fiona Hall from ECEEE also called for strong legislation on energy retrofit. "Setting out a clear long-term vision for the building stock in the EPBD will boost consumer confidence and demand in a market eagerly waiting to lend a helping hand," she said.

Meanwhile MEP Miapetra Kumpula-Natri stressed the importance of governments supporting financing initiatives targeted at helping the energy poor: "We must strive for a coherent package of legislation on energy renovation which will benefit all in society," she said.

"Contrary to popular belief, money is actually not the issue here," said Adrian Joyce from Renovate Europe. "As you heard, the banks are keen to invest, but they cannot address the latent demand. They need governments to support stronger legislation which outlines a clear path to achieve a highly energy efficient nZEB building stock in the EU by 2050, in order to stimulate consumer awareness and demand in the market". ■

Passive house district uses one-third the heat of typical apartments — report

Passive apartment buildings in the Bahnstadt district of Heidelberg have been proven to perform remarkably close to the calculated space heating targets for the passive house standard.

A major research project by the Passive House Institute has found that heat energy consumption of the passive house district of Bahnstadt, in the city of Heidelberg, Germany, is roughly one-third that of conventional housing developments.

As part of the project, the Passive House Institute studied the energy consumption of 1400 apartments, including 563 student accommodation units, over the course of 2014 and 2015.

"With regard to the total energy consumption, this is just a third of the normal district heating consumption in apartment buildings, which means two-thirds less energy costs in the Bahnstadt district," said Søren Peter of the Passive House Institute.

In 2007, the city of Heidelberg stipulated that all buildings within the 116 hectare district of Bahnstadt must be built to the passive house standard. The area is currently home to about 3,500 residents, as well as to kindergartens, restaurants, bars, a DIY Store, and a school that will open this year — all built to the passive house standard. A large shopping centre is currently under construction, and a fitness club is also being planned.

The Passive House Institute's heat energy consumption figures for Bahnstadt include space heating, hot water, distribution and storage heat losses. Monitoring showed that the buildings in the Bahnstadt district used just one-eighth of the space heating energy required for existing buildings, with average space heating demand of 14.9 kWh/m^2/yr for 2014 and 16.4 kWH/m^2/yr for 2015, a year which experienced a colder winter with less solar radiation.

The average electricity consumption of individual dwellings was just 17.9 kWh/m^2/yr. Reacting to the report, Passive House Institute director Prof Wolfgang Feist pointed out that the passive house standard already meets the EU's nearly zero energy building standard, which will be compulsory from 2021. ■

Passive House Plus most circulated green building mag in the UK

Passive House Plus has the highest circulation of any sustainable building magazine in the UK, and is one of the most widely circulated construction trade magazines in the country, new data from the Audit Bureau of Circulations (ABC) has revealed.

ABC's latest business media report shows the magazine having a circulation of 9,299 copies for the audit issue. This indicates a true readership of almost 30,000, based on the publishing rule-of-thumb that a typical magazine will have roughly three readers for every copy that is printed and circulated. The digital edition of the magazine has about 1,600 readers.

"We're thrilled," said Passive House Plus editor Jeff Colley. "Passive House Plus has the highest circulation of any sustainable building magazine in the UK. This gives us an unrivalled opportunity to educate, inform and influence – for the better, hopefully – the design, specification and construction of new build and upgrade projects the length and breadth of the country, and help to move the market towards robust, cosy, healthy buildings which minimise energy use and overall environmental impacts."

According to Colley, the magazine's success is based on a growing need for technically literate, objective information on sustainable building. "If you look at building practices, one area stands out as unrecognisable from where we were ten years ago: energy performance. The industry is having to learn about new techniques, materials and technologies to build low energy buildings – and to avoid the unintended consequences of making the wrong choices."

Meanwhile Passive House Plus now has the third highest circulation of any business magazine in Ireland. The latest ABC Island of Ireland report lists the circulation of the printed Irish edition of the magazine at 7,111 copies, based on the audit issue. Only two titles – Accountancy Ireland and retail news magazine Shelflife – posted higher results. ■

Buyers sought for Hampshire passive house scheme

(above) An illustration of the two passive houses at 6a Vision Homes' Holders Yard development in Petersfield, Hampshire, both of which are available to buy (left).

Residential development firm 6a Vision Homes has just started on site with a seven-unit development in Petersfield, Hampshire that will feature two passive house units. The firm is now seeking potential buyers to come on board and actively shape the final specification of the properties.

The Holders Yard development will feature two pairs of semi-detached homes, a pair of linked detached units, and one further detached unit, on a site that includes two conservation buildings, a chimney and a barn. This will be the firm's first passive house project.

"We're a small, high quality young development firm, and our model is to work within 15 minutes of our hometown of Petersfield," James Allen of 6a Vision Homes told Passive House Plus. "We decided we're looking to take on the unknowns of passive house because we feel it's the right way to go."

He added that quantifying the extra cost of building to the passive house standard will be on one of the main challenges of the project. "At the end of the process we should have a really clear idea of those costs. We'll be able to see if passive house sells for a premium, and if the model works for speculative developers."

He continued: "We have always built to a very high quality. We use top quality materials, so the building will look great in 10 and 20 years time. Nothing will deteriorate."

"The real challenge for us now is to try to hit passive house levels. I think that's going to test our build team quite heavily, but it's pushing things for the right reason. It will also hopefully be an education to the local community as to what passive house can do and can offer." For more information, see **www.6avision.co.uk**. ■

Europe must curb emissions from buildings, urges coalition of 300 groups

Europe must lead the world on cutting greenhouse gas emissions from existing buildings in order to meet the ambition of the Paris Agreement, a coalition of over 300 businesses and organisations from across the continent has urged.

The coalition, which includes cities, public authorities, property developers, manufacturers and energy utilities, as well as trade associations, NGOs and universities, is calling for ambitious national renovation strategies that set out clear targets and measures for transforming existing buildings.

The move comes as EU member states near the deadline to publish updated strategies to renovate their buildings, which account for around 36 per cent of Europe's total greenhouse gas emissions, and as political decision-makers grapple over the future of EU energy laws for the construction sector.

This groundswell of support for more ambitious European renovation policy follows the conclusion of Build Upon, an EU Horizon 2020 funded project, in which 13 Green Building Councils in Europe played a leading role in helping national governments to create "strong and robust strategies" on energy retrofit.

Their recommendations have now been released in a series of publications by the World Green Building Council, the coordinating organisation behind Build Upon. The publications set out actions for how countries can deliver the level of ambition needed on existing buildings that will meet the Paris Agreement.

These recommendations include: better engagement with citizens on the benefits of energy retrofit, upskilling the construction industry to help transform Europe's existing buildings, the need for innovative renovation financing, regulation to make renovation mandatory under certain conditions, and better co-ordination between public, private and civil society bodies on retrofit.

"Europe is at a crossroads in terms of its energy policy, with decision-makers unwilling to commit to a clear vision for one of Europe's most pressing climate challenges – its buildings. But this intervention is proof that a large number of businesses and organisations are committed to ambitious plans on building renovation," said James Drinkwater, regional director of the World Green Building Council.

For more information see **www.buildupon.eu**. ■

Change habits to tackle climate change, passive house conference hears

(right) Over 1000 delegates from over 50 nations attended the 21st International Passive House Conference in Vienna on 28-29 April.

Changing habits was a big theme at the 21st International Passive House Conference, which was held in Vienna on 28 and 29 April, with leading climate researcher Helga Kromp-Kolb telling delegates that adopting new habits and sharing resources fairly were both crucial to tackling climate change.

"We have to manage with just this planet," Passive House Institute founder Professor Wolfgang Feist told the conference, which was attended by more than 1,000 participants from over 50 countries. "The passive house standard is affordable and feasible for everyone, you just have to use your head a little bit," he also said.

Meanwhile Günter Liebel of the Austrian Ministry of the Environment told delegates: "The technology for energy efficient construction is already there, now it is all about implementing it in practice and building cleverly." He also emphasised the need for a dialogue on low energy building and refurbishment with those in traditional fossil fuel sectors.

Scott Foster, an expert on sustainable energy with the United Nations Economic Commission for Europe, also echoed the need for humanity to change its habits. "We must break through this system which is designed to produce and deliver more and more energy," he said.

The conference also heard more than 100 presentations from speakers from over 50 countries, including a lecture on the Tochoji passive house temple in Tokyo and a presentation on a mobile passive house with 40 sqm of living space, produced by a 3D printer. Meanwhile, the topics of the 16 working groups included the passive house standard and renewable energy, passive high-rise buildings, passive house retrofit, and other exemplary international projects.

Participants also took part in eight excursions to passive house projects around Vienna, which is one of the world's leading cities for passive house construction, with high-rises, hotels, large multi-storey buildings and student dorms built to the standard. It was also announced that next year's International Passive house Conference will take place in Munich on 9 and 10 March. ■

New study blames poor energy modelling for performance gap

Thousands of new buildings may be using much more energy than they are predicted to, according to a new study by the University of Bath. The study of UK non-domestic buildings found that many use twice as much energy and emit twice as much carbon dioxide as the professionals who designed them predicted.

The research has suggested a new reason for this 'performance gap', the difference between how much energy a building is predicted to use and how much it uses in reality. Lead researcher and low carbon design expert Prof David Coley explained: "Previous research has assumed the performance gap can be attributed to the construction and operation stages.

"However, we have revealed a new cause for the performance gap, that being the modelling illiteracy of building modelling professionals arising from the modellers being separated from the rest of the construction process and the final building."

In the first research of its kind, a team from the university's architecture and engineering department, and its psychology department, interviewed 108 building modelling professionals about 21 common energy-related aspects of a building, from the insulation in the walls to the temperature the heating was set to. The questioning was based on a real building in which detailed energy, occupancy and temperature data had been recorded.

The researchers found that the building modelling professionals could not agree on which of these 21 aspects were important to the building's energy performance and which were not, or how much difference to energy consumption changes to them would make.

A quarter of those interviewed were judged to be no better than if a member of the public had responded at random. The study also found that an energy modeller's level of qualification or experience did not improve the accuracy of their answers.

Co-investigator Dr Ian Walker of the university's psychology department said: "Currently, an in-depth qualification for building modelling does not exist, meaning there is little formal training process for those entering the profession. If this aspect can be addressed, part of the performance gap could rapidly be reduced." The study is online at **www.tinyurl.com/y8uujgtr**. ■

1930s Bristol property reborn thanks to AECB Silver retrofit

This challenging energy upgrade and remodelling turned an old industrial unit into a unique modern home.

Words by Mischa Hewitt, Earthwise

Clients: James & Poppy Walker
Designer: James Walker
Structural engineer: Milner Associates
Energy modelling: Earthwise (www.earth-wise.co.uk)
Contractor:
Earthwise Construction (www.earthwiseconstruction.co.uk).

In 2007, James and Poppy Walker bought a 1930s light industrial live/work unit in Bristol. They were immediately drawn to the big open spaces with high ceilings and set about making it their home. A few year ago, motivated by the need for more living space to accommodate their growing family, they decided to extend and refurbish the building while reducing their energy consumption by aiming for the AECB Silver energy standard. As a structural engineer specialising in timber construction, James designed the conversion and retrofit himself, with energy calculations done by Earthwise.

The AECB Silver standard is a low energy standard based on the passive house standard. The aim of AECB Silver is to drive better building design with a 'fabric first' approach that focuses on insulation, thermal bridging, high performance glazing, airtightness and mechanical ventilation with heat recovery (MVHR). The standard is less demanding than passive house and has a self-certification process, which is attractive to self-builders and those on a tight budget as it is cheaper than passive house certification, while maintaining technical rigour. AECB Silver is recognised by the Ecology Building Society and is eligible for discount on its C-Change mortgage. In the UK, 27 projects have been certified to the standard so far.

Wellington Lane is in a conservation area in central Bristol and is a narrow cul-de-sac. The building occupies the whole plot apart from a small strip of hard standing to the front, making the logistics of the build a challenge. The most complicated element of this project was the installation of the glue laminated (glulam) roof beams and insulated roof panels. This required careful planning, as the only way to install the beams was with a crane, meaning that the road had to be closed for two days. The building was carried out by Earthwise Construction and took five months.

With no outdoor space and limited room to extend the house sideways, the new development added a second storey and roof terrace. The downstairs is characterised by a generous entrance hallway, and the upstairs by a wide curved roof and large open plan living area. The front terrace extends the living area and is finished with flagstone tiles and vertical larch cladding. Other materials included wooden floors, stone tiles, exposed brick, smooth plaster and industrial roofing sheets. The eaves overhanging at the front of the building give good shading in summer to prevent overheating, but allow the low winter sun in.

Exposed structural timber features prominently in the new building, reflecting James's expertise in timber engineering and Earthwise Construction's preference for natural materials. Bespoke curved glulam timber beams were designed as the main load bearing roof structure. Glulam beams are small pieces of timber, glued and laminated for increased strength, and can be used to replace steel as load bearing elements. The use of curved glulam beams maximised the height of the new storey without overshadowing neighbouring gardens.

High performance phenolic foam insulation was used throughout, and the walls, roof and floor have all been insulated beyond current UK building regulations. It was a challenge to integrate some of the new building elements with the existing ones, particularly where the original structure penetrates the new insulation layer. Earthwise Construction worked closely with James to ensure continuous insulation could be maintained where the new structure meets the original building.

Once the building had been highly insulated, the next step was to reduce draughts by sealing the building. A pro clima Intello Plus membrane was wrapped around the whole building and was taped and sealed at every junction. Parts of the existing structure that were retained were challenging to seal. There is currently no requirement to pressure test existing buildings for airtightness when they are retrofitted in the UK, but the AECB Silver standard requires it. The project beat the AECB Silver airtightness criteria achieving an air permeability of 0.81 $m^3/hr/m^2$, which is over 10 times better than the building regulations require.

Heating and hot water is provided by a highly efficient Worcester Greenstar 12i ErP system boiler range with 250 litre unvented cylinder. The ventilation system is a Paul Focus 200 MVHR system supplied by Green Building Store. There is low energy LED lighting throughout, and a 4 kWp solar photovoltaic array.

The project was completed in summer 2015 and the measured primary energy demand is 80 kWh/m^2/yr, which is 30% better than predicted by the PHPP model. The project was the winner of the best self-build prize at the Structural Timber Awards last year.

For more information on the AECB Silver standard see **www.aecb.net**. ■

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A BRAVE NEW WORLD:

Oil and architecture

Innovations in low energy building were spurred in the 20th century by oil crises, but the political impetus for meaningful change receded once the crises ended, explains Dr Marc Ó Riain, bringing an attendant failure to set meaningful building regulations.

It always shocks me that Ireland did not manage to introduce mandatory building standards till 1992, when the UK had standards soon after the great fire of London 1667 and first published enforceable national building energy regulations in 1964. The relationship between the lobbyists, government policy, geo-political/economic factors and oil prices have long been intertwined and interrelated. External factors have changed our priority toward energy consumption in buildings, making us as consumers more aware of building energy costs or less concerned with them when designing our buildings. What is clear is that regulations play a seminal role in setting a baseline for investment decision-making and the absence of regulations (of adequate enforcement) would allow for the unfettered priorities of the market to drive down standards, which can lead to the disasters we have seen illustrated in Ireland by high profile building failures at developments such as Priory Hall, Longboat Quay and Millfield Manor.

Political priorities since the first oil crisis in 1974 have led to national policy positions that have undermined advances in renewable technologies, mandatory standards, and financial business cases for low energy buildings.

The devastation of World War 2 blitz bombing created an effective tabula rasa in the cities of Europe. Post war reconstruction was limited by the shortage of experienced bricklayers and the slow nature of traditional building techniques, resulting in a shift towards modular prefabricated systems which became synonymous with social high rise housing in London and its new towns. The battle "between the hards and the softs…the Corbusian rationalists and these Swedish empiricists" (Kite 2010) was won by the modernists who embraced the new construction technique "with the use of concrete, steel and glass…to be ugly in its mechanical simplicity" (Sant 'Elia 1914). The clear structural rigor and tectonics of the steel frame metal and brick campus building at IIT during the war by Mies van der Rohe, would be supplanted by more cost-effective and brutalist concrete frames and external cladding panels in the UK in the 1950s best characterised by some of the buildings on the redeveloped South Bank for the Festival of Britain (1951). A common feature of many of these post-war concrete buildings is a high level of strip single glazing, exposed concrete and a lack of insulation, with high amounts of heat gain and loss.

In 1963, the Irish government introduced a Planning Act to control unfettered development, but failed to introduce building regulations. A low level of political, consumer or design priority was placed on energy in buildings as oil was abundantly cheap up to the winter of 1973.

In October 1973, as people were filling their home heating tanks with oil at $30 per crude barrel (inflation adjusted), an Egyptian and Syrian offensive against Israel resulted in the Yom Kippur War. The US supplied arms to the Israelis and Arab nations responded with the OAPEC coordinated oil embargo against the West (Merrill 2007), resulting in long queues for petrol, fuel rationing and the exhaustion of national reserves. The cost of a barrel of oil quadrupled to an inflation adjusted €120 a barrel.

> "Political priorities since the first oil crisis in 1974 have undermined advances in renewable technologies, mandatory standards, and financial business cases for low energy buildings.

The embargo highlighted national dependencies of imported fuels, the importance of oil reserves, economic exposure and made the consumer suddenly realise the cost of heating in their uninsulated buildings. Long queues at petrol pumps and high home heating oil costs brought considerable pressure on governments to develop policies to mitigate against the repetition of such an embargo on their economies.

In February 1974, the majority of the western world's oil consuming countries (including Ireland and the UK) came together in Washington at an energy conference led by the US organised by Henry Kissinger. The conference developed common policies on energy production and conservation, alternative energy sources, research and development, emergency sharing, financial co-operation and energy security and led to the foundation of the International Energy Agency later that year in Paris.

The formation of the IEA cemented UK and US policies of energy independence, shifting their focus to increasing oil and gas exploration, along with the development of nuclear power stations. Denmark by contrast invested heavily in wind, district heating and energy conservation research. Such policies led to the first zero energy house being built in 1975, in Copenhagen, based primarily on energy conservation and seasonal solar water heating. The US would introduce 'weatherisation' programs, for draft sealing and insulation for existing buildings and the UK

Dr Marc Ó Riain is the president emeritus of the Institute of Designers in Ireland, a founding editor of Iterations design research journal and practice review, a former director of Irish Design 2015, a board member of the new Design Enterprise Skillsnet, and has completed a PhD in low energy building retrofit, realising Ireland's first commercial NZEB retrofit in 2013.

(clockwise from top left) Cars queuing for petrol in London during the 1979 oil crisis; the Saskatchewan Conservation House in Canada, one of the pioneering low energy houses of the 20th century, was built in 1977; constructed even earlier was the Solar 1 house at MIT, which was built in 1939, and featured 33 sqm of solar thermal panels and a huge storage tank to meet its heating demand.

introduced grants for attic insulation in the late 1970s. Ireland followed suit twice with successful attic insulation incentives in the early 1980s.

Architectural design principles for low energy buildings and renewable technologies were informed initially by Solar 1 at MIT as early as 1939, with a small number of architects developing optimally oriented houses for solar heating using trombe walls and seasonal water storage tanks through the 1960s. However, the passive house standard which we know today was initially informed by these early solar houses, depended more on the developments after the first oil crisis. Technical developments and research projects such as the Phillips House (Aachen, 1974), Bentley's Double Wall House (patented 1976, USA), Schick's Lo-Cal House (Illinois, 1976) and the Saskatchewan Conservation House, Canada (1977) would become baseline precedents for the 1988 standard. Building retrofit technologies and thermal bridging pioneered by the Princeton House Doctors at the Twin Rivers Retrofit between 1976-1979, established that insulation and airtightness gave far better payback periods than active systems like seasonal storage tanks.

The sheer volatility of imported energy prices from 1974 to 1986 had a serious impact on industry, economy and politics. The cost of oil and the security of its supply became a key driver of international political policies informed by the IEA. The volatility of prices brought the cost of energy consumption into stark clarity and the consequences of political inaction in building regulations in Ireland were addressed for the first time, albeit on an elective basis.

In 1976, Ireland introduced elective building regulations and the UK revised its mandatory building energy standards. Although Irish U-Values (below) were more onerous than the UK regulations (below), critically they were not mandatory and not applicable to existing buildings.

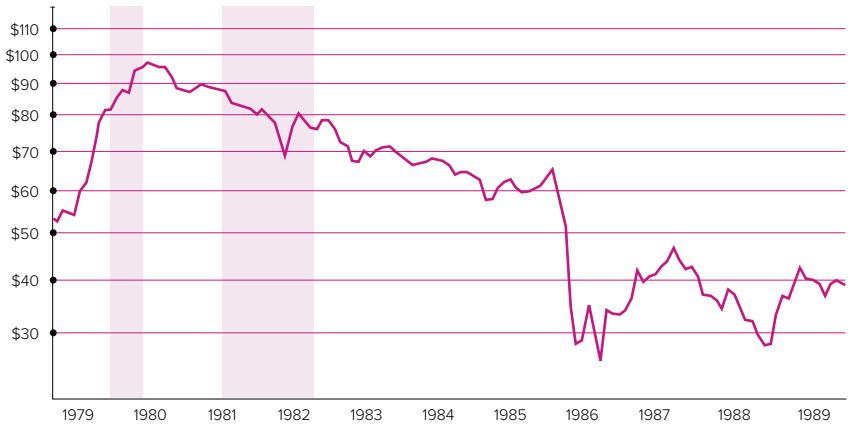
Irish elective building energy standards 1976	
Building element	U-Value (W/m²K)
Wall	0.6
Attic	0.6
Floor	0.6
Roof	0.4

UK mandatory building energy standards 1976	
Building element	U-Value (W/m²K)
Wall	1
Attic	1
Floor	1
Roof	0.6

By the late 1970s a body of knowledge in low and zero energy building had developed, supported by micro industries providing renewable technologies such as solar panels, seasonal storage tanks, heat pumps, district heating, and insulation. The demand for lower energy buildings was supported by high crude oil prices, which peaked at the equivalent of $117 per barrel following the Iranian revolution in 1979.

However, the arrival of Thatcher and Reagan to power in 1979 and 1980 resulted in a collapse of oil prices over a six year period, destroying the demand for low energy buildings and destroying the fledgling renewable energy industry. As oil prices fell, architects shifted their focus away from building performance as demand dried up. In 1988, inspired by the early precedents, Wolfgang Feist and Bo Adamson developed the passive house standard in the backdrop of historically low energy prices. Spurred by a nightclub fire tragedy, Ireland would finally introduce mandatory building standards in 1992.

In the next issue I'll examine the development of mandatory building standards in Ireland, the EU Energy Performance of Buildings Directive and the potential for UK and Irish governments to address climate change through built environment initiatives. ■



Inflation-adjusted oil prices 1979 - 1990 (Macro trends 2016)

OUR PASSIVE JOURNEY

Preparing to go to tender

In the sixth report on her journey to self-build a passive house, Nessa Duggan struggles to reconcile glazing functionality and thermal performance, takes on conflicting advice on heating and ventilation, and reaches some decisions on joinery.

As we continued to gather and process information for a tender package for our self build, windows were the next big ticket item on the list. We were advised to work within a budget of approximately 10% of the build cost for alu-clad passive certified windows, and to send out a window schedule for pricing prior to issuing a tender. The most expensive quote was approximately twice the price of the least expensive! We needed to see the windows in person to appreciate the cost benefit of the different options.

One commonality was that the extensive glazing in the kitchen – two walls of six metre wide floor-to-ceiling glazing meeting at a corner – contributed approximately half of the cost of the 33 windows in the house. As Jeff O'Toole had advised prior to completing the PHPP calculations, it would be challenging to achieve the necessary airtightness for the passive house standard with a pair of three metre wide sliding glass doors. The window suppliers all suggested fixed glazing for all units in the kitchen, defeating the purpose of the covered deck area adjacent to the kitchen.

From a practical point of view, two walls of glass and one wall of kitchen units leaves very little wall space. We felt this limited the function of much of the space in the kitchen. One glass wall directly faces the boundary wall of the site which is only six metres away. These considerations, together with discussions on the structural requirements to support the large roof overhang, made us rethink the huge expanse of glazing at the back of the house. Another one step forward, taking us two steps back.

With this conundrum in mind, we set off for the Self Build Show in Belfast one dreary Sunday afternoon, with the hope of a blitz of efficient information gathering to make a few informed decisions and fast track the process after weeks of little progress. Our main aim was to speak to window suppliers, timber frame manufacturers, and suppliers of heat pumps and heat recovery ventilation systems.

It was time well spent – there's nothing like face to face discussion and being able to see and feel the products to get a sense of the quality of products and service you might expect from suppliers.

We got a great appreciation for the variation in quality and aesthetics from the window displays and thought the quality was in proportion to the pricing, in that you get what you pay for. We spoke to several timber frame manufacturers and discussed their approach and the options for our project, leaving this particular topic with more questions than answers.

When it came to heat recovery ventilation and heat pump technology, we didn't get a sense of impartial advice. A few exhibitors at the show hit us with the hard sell, assuring us that their option was the best fit and scaremongering that all the prior advice we had been given was incorrect. After five hours of listening to the sales spiels of the various reps, with only the typically poor sustenance on offer in the exhibition arena to keep us going, we were exhausted.

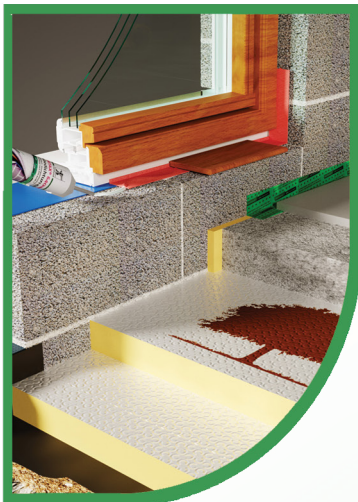
Going back to rewiring my long-term admiration of walnut joinery and picking an alternative for the doors, architrave, skirting and window boards – in my mind, this is a big decision, and one that may limit options for yet to be chosen floor/wall finishes throughout the whole house. In my mind, the next obvious choice was oak and personally I prefer bolder colours. This in mind, I went along to 'an evening of colour' at my local Colourtrend shop, in an effort to pick up some tips on where to start with selecting colours for the blank canvas a new build is.

Our current home is covered from top to bottom in Colourtrend paint. I've returned time and time again because of the beautiful colours, and because it's Irish, really durable and the staff at my local showroom are really helpful and full of great advice for decorating. I had high hopes, and was not disappointed.

> Extensive glazing in the kitchen – two walls of six metre wide floor-to-ceiling glazing meeting at a corner – contributed approximately half of the cost of the 33 windows in the house.

Adele Roche, a colour specialist and interior designer, gave a very practical and informative talk that really resonated with me. She described an inclination I recognised in myself, a love of natural wood and a senseless notion that it's not really a colour, and painting it is depraved. At the end of the day, wood has a colour – usually a hue of yellow – that must be considered when choosing a colour scheme. In addition, most people have furniture of various types of wood, that all limit creating a desired look.

Adele showed some photos of projects she had completed recently, examples of stunning joinery painted navy and burnt orange. This was a eureka moment and decision made: specify primed joinery on our tender and hire Adele when the decision needs to be made on what colour the joinery will end up. This felt like a big step forward in the process! ■



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SUFFOLK ECO HOME EMBRACES

WOOD & WARMTH

This cellulose-filled timber frame house in the Suffolk countryside combines a rustic timber aesthetic with a simple contemporary form to rest lightly on the land.

by Lenny Antonelli

Building type:
202 sqm timber frame house + 30 sqm studio
Standard: A-rated
Location: Palgrave, Suffolk
Completed: 2012
Budget: £720,000
Heating:
Air source heat pump & wood burning stove
EPC: A
Energy bills: £1,512/yr

Photos: David Butler

WANT TO KNOW MORE?

The digital version of this magazine includes access to exclusive galleries of architectural drawings.

The digital magazine is available to subscribers on www.passive.ie

> WE WANTED A HOUSE OF TRADITIONAL TIMBER CONSTRUCTION — WE WERE NOT IN THE MARKET FOR A GLASS PALACE.

Homeowner Ian McClintock says that among he and his wife's Jane's key priorities for their new Suffolk home, dubbed Stackyard House and designed by Mole Architects, was embracing "economy and sustainability".

And these principles are reflected in both the design and performance of the house: the focus on timber, the ultra low energy performance, the simple and economical form.

"We wanted a house of traditional timber construction — albeit using modern methods and only the discrete use of more modern materials," says McClintock. "We were not in the market for a glass palace."

Having lived in cold and draughty Suffolk farmhouses before, the couple wanted a house that would look after them as they grew older — rather than needing to be looked after. "We wanted a home for our old age that gave us the benefits of modern living but didn't differ too far from our roots," McClintock says.

They also wanted a dwelling that would sit neatly beside an adjacent 16th century farmhouse, and enhance the local landscape.

Stackyard House isn't a passive house. Although PHPP calculations early on in the design showed the building could be close to passive house, the passive approach wasn't pursued as the design iterations advanced and eventual specifications were decided. Indicative PHPP calculations provided by Andrew Fisher of passive house consultants Whole House Energy point to a space heating

Client's view: Ian McClintock

I would say that the biggest challenge for me during the project was financial: keeping track of ongoing expenditure whilst weighing up the implications of each and every decision. In the latter stages that challenge changed to concerns over understanding the technicalities involved with the various, mainly electronic, systems on which the house depends. However it must be acknowledged that through the many and varied challenges we were expertly guided by Meredith Bowles and his team.

Previously, Jane and I had lived in centuries old houses that tended to be dark, draughty and — in winter — cold in all areas away from the Aga or woodburner. On moving into Stackyard House we suddenly found ourselves in a fantastic, all-round warm environment, with not a radiator in sight! That was in the wet winter of 2012/13 and very cold spring of 2013. The natural light seemed miraculous.

One downside is that electricity costs have been higher than expected. Although features such as the air source heat pump, heat recovery ventilation, solar water heating and rainwater saving have undoubtedly given us the sustainability we set out to achieve, I have to say that electricity costs have been higher than expected. There is a seemingly relentless rise in energy costs which may account for some of this, but generally it is driven by increasing usage. Clearly we have used more electricity as our activities are more and more dependent on electronics, but I suppose the most likely cause is our use of greater heat in our increasing dotage.

Perhaps I need to remind myself that we have no other energy costs whatsoever — no oil, gas or solid fuels. Even the woodburner, which has minimal use, is in all honesty rarely needed for additional heat — only to provide some cheer on cold, dreary winter days.

demand of 27 kWh/m^2/yr – low but some way outside of the passive house target of 15.

Heating at Stackyard House is provided by an air source heat pump and wood burning stove, though the stove is rarely used.

Ian and Jane were keen on timber frame, and choose a prefabricated system from Just Swiss Timber Construction, clad externally with ply sheathing. The architects were keen to use wood too. "We enjoy working with timber for its precision, warmth, forgiving nature, lack of wet trades, speed of construction, and timeless beauty," says Bowles.

Project architect Tim Offer recalls that the prefabricated panels, pumped with 240mm of recycled newspaper insulation, were sheathed on the inside with 'living board', a type of OSB that served as the airtight layer, with tapes and membrane at edges and openings.

A 30 sqm studio adjacent to the house was built to a slightly different spec – 150mm timber stud walls filled with Kingspan insulation, bespoke joinery with double glazed units, no mechanical ventilation and no airtightness test. "Jane wanted a rough and ready space to make a mess in!" says Tim Offer.

Even before Stackyard House was built in 2012, Mole Architects had been unwittingly working towards the fabric-first goals of the passive house standard on a number of projects, before formally coming across the concept. And getting near the standard actually wasn't too onerous at Stackyard. "They had few site constraints, so we could accommodate the right kind of form and openings with ease," Bowles says.

His principle design goals for the house? "To be light and joyful, to live with the sun all day, to take advantage of aspect, to shelter and comfort, and to express beauty in its construction and form."

You'd be hard pressed to say that he didn't achieve them.

Explained:

Fabric First, the principle of designing a building fabric that keeps in heat — through a well insulated, airtight structure that is free of thermal bridges — before thinking about 'bolt-on' technologies like renewable energy.

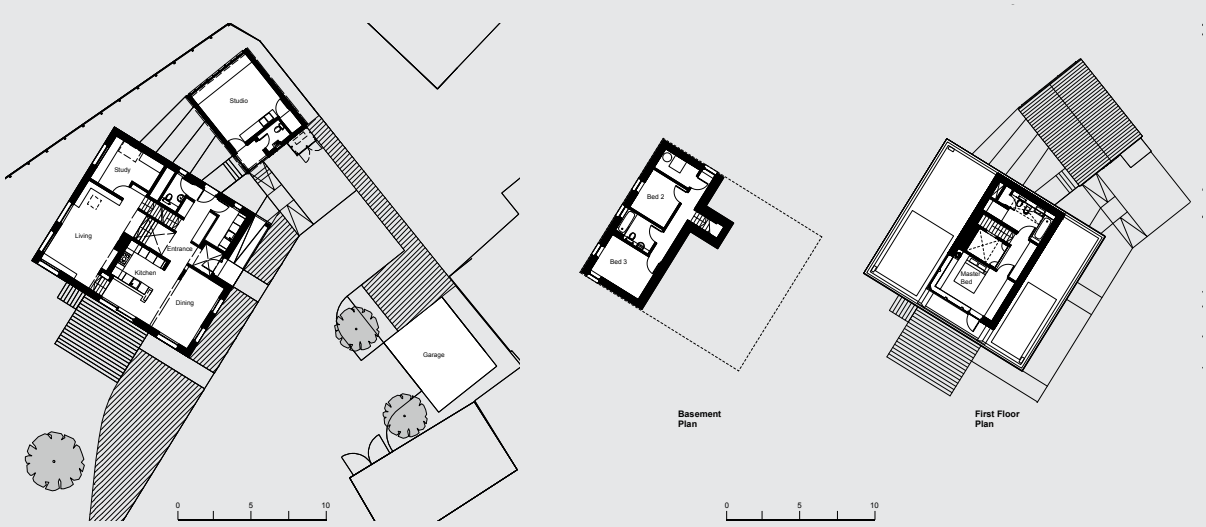
SELECTED PROJECT DETAILS

Clients: Ian & Jane McClintock
Architect; Mole Architects
Project architect: Tim Offer
Civil & structural engineer: JP Chick & Partners
Indicative PHPP calculations: Whole House Energy
Timber frame: Just Swiss Timber Construction
Main contractor: Willow Builders
Quantity surveyors: Sheriff Tiplady Associates
Mechanical contractor: ABC Plumbing & Heating
Electrical contractor: Norwich Electrical
Additional wall insulation: Celotex
Roof windows: Sunsquare
Sliding Shutters: Hafele UK
Cladding: Marely Eternit
Ventilation: Anglia Air Conditioning
Windows: Velfac
Heat pump: Vokera
Lighting: Wow Lighting
Thermal breaks: Foamglas

CONSTRUCTION IN PROGRESS

(above, from left) 50mm Celotex insulation is fitted in the service void internally; a section of the closed panel timber frame system being craned into place; the prefabricated panels are fully filled with 240mm of cellulose insulation.

IN DETAIL



Building type:
202 sqm timber frame house
+ 30 sqm studio

Standard: A-rated

Location: Palgrave, Suffolk

Completed: 2012

Budget: £720,000

EPC: A

Energy bills: £1,512 (average from 2013-2016, including £1832 annual bills minus £320 generation payment. Taking account of space heating (minus wood stove), domestic hot water, lighting and plug loads – and also including 30 sqm studio.

Space heating demand (PHPP):
27 kWh/m²yr

Heat load: 16 W/m²

Primary energy demand (PHPP):
135 kWh/m²/yr

Measured primary energy demand:
145 kWh/m²/yr

Airtightness (at 50 Pascals): 0.86 m³/hr/m²

Energy performance certificate (EPC):
A – 94 (Predicted)

Overheating (PHPP, percent of year above 25C): 9%

Ground floor: 20mm ash flooring or stone on 60mm screed with underfloor heating laid onto 200mm rigid insulation over Newton DPM, on structural slab, with cork expansion strips to edge of timber floors. U-value: 0.10 Wm²K

Walls: 271mm wall (including 240mm closed panel plus 15mm and 16mm sheathing on either side) fully filled with cellulose insulation, and 50mm Celotex insulation in service void. Internal timber stud walls supplied by timber frame manufacturer with lining to one side only. Plasterboard lining in main contractor's work. U-value: 0.13 W/m²K

Roof: Felt roof membrane with integrated wearing layer. 200mm Ecotherm insulation laid to 1:80 falls. Vapour barrier laid over JS deck and lapped up parapet to form overlap with waterproofing membrane. Beams and deck left exposed. U-value: 0.11 W/m²K

Windows & doors: Velfac 200 outward opening windows. Aluminium clad timber framed triple glazed windows.
U-value: 1.2 W/m²K.

Roof windows: Sun Square Aero Electic triple glazed roof windows.

Heating: AriaPro 8kW air source heat pump with Aquaflow TC250 twin coil cylinder, delivering to underfloor heating

Ventilation: Mitsubishi Lossnay LGH-50RSDC-E1 mechanical ventilation with heat recovery system, with a Sap Appendix Q-rated efficiency of up to 85%.

“

NORWICH CITY COUNCIL’S AMBITION IS TO SEE 1,000 PASSIVE HOUSES BUILT IN THE NEXT 10 YEARS.

Building type:
8 detached & 6 semi-d passive houses, from 72 to 133 sqm

Location:
Hellesdon, Norwich

Build method: Externally insulated poroton block

Standard:
Passive house certified

EPC: B

Heating: Gas boilers

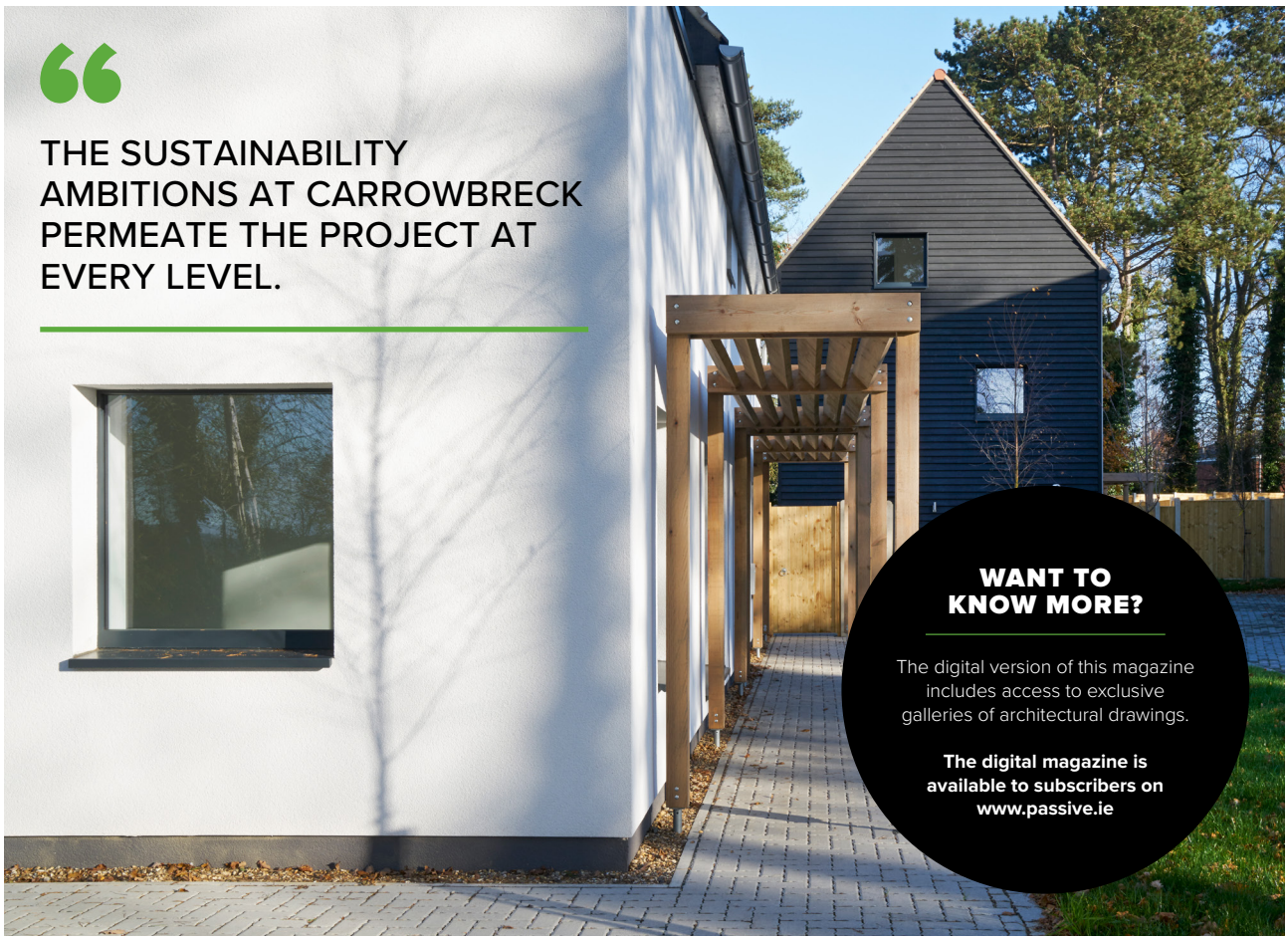
Heating bills: £27 - £55 per year

AFFORDABLE HOMES SCHEME REFLECTS RISE OF NORWICH

AS A PASSIVE HUB

A new development of passive housing on the outskirts of Norwich shows how to combine energy efficiency, ecology and affordability on one exemplary site — and why the city continues to be an unlikely leader in pushing passive house construction in the UK.

by David W Smith



> THE SUSTAINABILITY AMBITIONS AT CARROWBRECK PERMEATE THE PROJECT AT EVERY LEVEL.

WANT TO KNOW MORE?

The digital version of this magazine includes access to exclusive galleries of architectural drawings.

The digital magazine is available to subscribers on www.passive.ie

When architects Hamson Barron Smith won top prize at the Norfolk Constructing Excellence Awards in April for their £2.8m Carrowbreck Meadow passive house scheme, it was confirmation that Norwich has become the heartland of passive house development in the UK. Norfolk's capital city will see around 300 passive house units built over the next few years. Hamson Barron Smith is designing more than 120 of these homes and Mikhail Riches Architects are delivering a further 100 homes from their office in London.

Local authorities in Norwich have played a crucial role in pushing the local development of passive housing. Six of the 14 Carrowbreck units, for example, will be affordable homes built for Broadland District Council. In 2015, Norwich City Council introduced the 'Fabric First' framework, a collaboration between contractors with expertise in passive house construction, to assist the development of passive house projects. The framework is open to all local authorities and housing associations. At this year's Norfolk Constructing Excellence Awards, the Fabric First Institute — which runs training courses in passive house design and construction — was the overall runner-up to Carrowbreck.

Now, Norwich City Council's ambition is to see 1,000 passive houses built locally in the next 10 years.

Sarah Lewis, project architect with Hamson Barron Smith at Carrowbreck, says: "These are exciting times for passive houses in Norwich,

Photos: Jefferson Smith | Construction photos: Sarah Lewis, HBS

which is leading the way in the delivery of fabric first projects. The local authorities in Norwich are pushing the standard partly because it addresses issues of fuel poverty and environmental regulations. The message is getting out that councils can think on a grand scale. A lot of councils around the UK are looking at passive house as a benchmark because it provides more quality than the marketplace."

Lewis is an influential figure in the world of passive house development and a valuable asset for the city of Norwich, where she moved from London in 2014. Lewis qualified as a passive house designer after completing London's first passive house in 2010, in Camden, for bere:architects. She also created the PHPP modules for the east of England's first passive house designer course and has spoken three times at the International Passive House Conference.

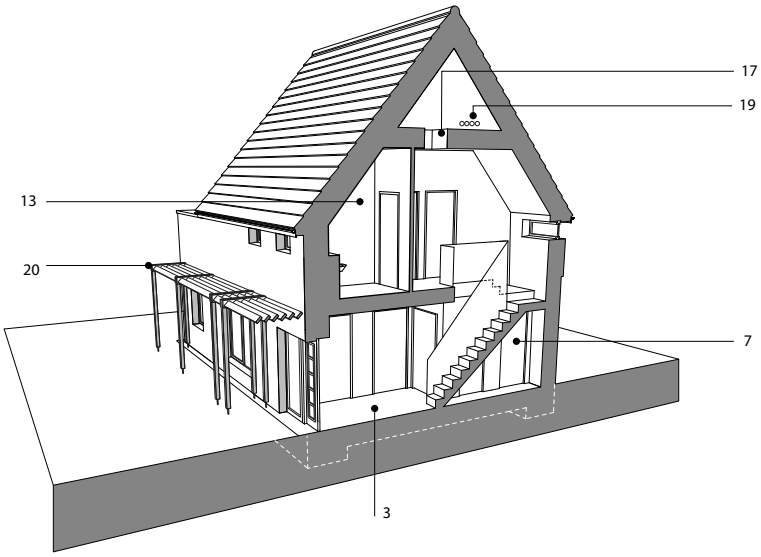
Carrowbreck is set in woodland and designed in the traditional Norfolk style, defined by references to the historic barn vernacular. All of the homes have electric car charging points, rainwater butts and connection points for solar PV. The positioning and orientation of the homes is designed to maximise access to solar gain in winter and prevent over-heating in summer, according to the architects, with brise soleil and venetian blinds providing solar shading. Carrowbreck was also one of the first UK projects to use 300mm Porotherm poroton blocks, which require 95% less water than traditional blockwork to manufacture.

The blocks have achieved an A+ BRE Green Guide rating, with 30% of materials from alternative, recycled, or secondary sources. At Carrowbreck, the blocks were insulated externally with Baumit OpenTherm EPS, which is new to the UK market (see architect's comment for more details). The timber roof elements are from Metsa Wood, who use "100% traceable wood from sustainable northern forests". Other low carbon materials were incorporated wherever possible, such as Warmcel cellulose insulation, which is made from recycled newspapers. Most materials came from local suppliers too.

Hamson Barron Smith is now conducting a full post-occupancy evaluation of the project as part of the 'soft landings' process with residents, including interviews with occupants, analysis of energy bills from all homes, and data collection from an advanced monitoring system in one home that gathers info on gas and electricity consumption as well as indoor temperatures, relative humidity and carbon dioxide levels.

Local contractors and sub-contractors were also crucial to the project. The main contractor was RG Carter, which has two bases in eastern England. Although RG Carter had never worked on a passive house project before, all of the homes here passed the stringent passive house air pressure test requirements of 0.6 air changes per hour at 50 Pascals on their first attempt.

Before beginning the project, RG Carter put its tradespeople and sub-contractors through the Fabric First framework training



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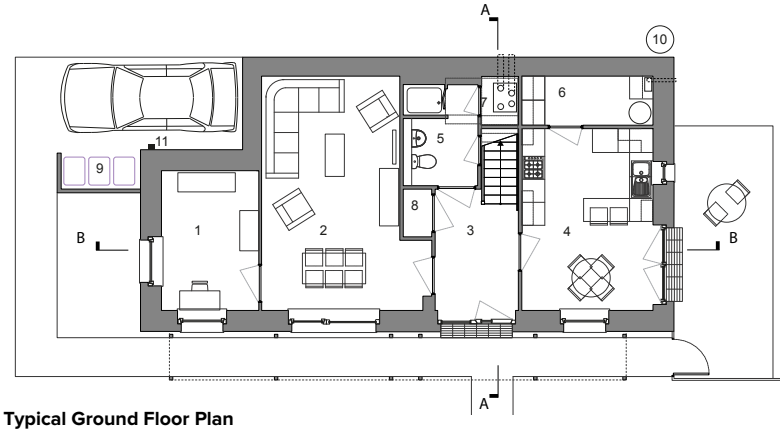
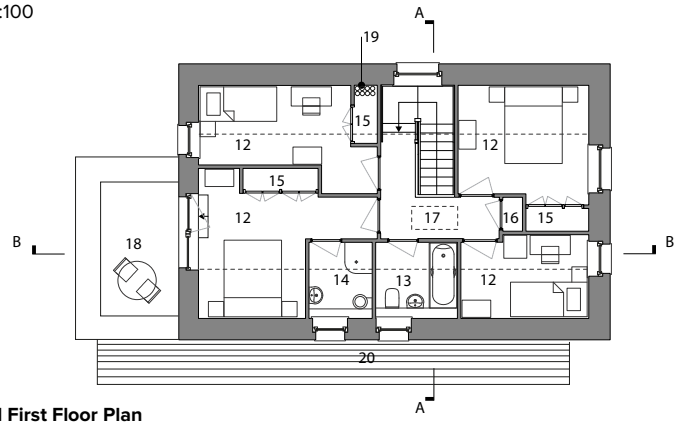


Typical Ground Floor Plan
Scale 1:100



Typical First Floor Plan
Scale 1:100

1 Study
2 Living / dining
3 Hall
4 Kitchen / breakfast room
5 WC / shower
6 Utility
7 MVHR cupboard
8 Cloaks
9 Bin / recycling store
10 Rainwater tank
11 Electric car charging point
12 Bedroom
13 Bathroom
14 Ensuite
15 Wardrobe
16 Cupboard
17 Loft access
18 Terrace
19 MVHR ducts
20 Brise soleil

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Ideas with a future.

programmes. Jackie Richards, director of Whole House Energy, which is responsible for the Fabric First training, says passive house training schemes for tradespeople normally take three days to complete and cost upwards of £1,000 per person. But here, the information has been condensed into a one-day course to supply the essentials.

"It's a long day from 8am to 6pm which is enough to teach the fundamentals about airtightness, insulation, thermal bridging and ventilation," Richards says. "It's a practical course as there's not enough time to go into a lot of theory and do a lot of maths and calculations. So we don't outline the details about ventilation, for example, but just teach them how to install it. But they find it's enough information for them to get the job done and very few know anything about passive house before they start."

For senior tradespeople who want to take their knowledge to the next level, there is a certified tradesperson training which lasts three days. The passive house designer course, meanwhile, is even more detailed, offering nine days of instruction. "All the courses are about more than passive house," Richards says. "It's really a case of educating tradespeople about how to construct quality buildings. They learn how to eradicate the energy performance scam, which is what we are up against. On average we use 16% more energy in our buildings than they've been designed for. Sometimes it can be 10 times more."

Richards agrees that Norwich has become one of the boldest and most forward-thinking regions for sustainable development in the UK. She believes the original inspirational for the change in approach came from the construction of the Enterprise Centre, at the University of East Anglia. Designed to showcase passive house development, it opened in June 2015, and is now recognised as one of the UK's greenest buildings. Professor John French, CEO of the Adapt Low Carbon Group, which commissioned the building and shepherded its construction, told the Guardian newspaper: "We wanted to create the ultimate sustainable building."

The team working on the passive certified Enterprise Centre sourced 70% of the building's wood from Suffolk's Thetford Forest. The building is wrapped in prefabricated, vertically hung thatch panel cassettes. Although vertical thatching has been used in places like Holland, prefabricating the thatch panels off site had never been done before. The panels were built in local thatchers' barns across Norfolk, and each timber cassette module was filled with tightly bound, locally-sourced straw.

Since it opened, specially designed software has continually monitored the building's carbon footprint. "The Enterprise Centre has created a lot of interest in passive houses in Norwich and the team that worked on it has moved on and disseminated their ideas," says Richards.

Despite the inspirational presence of the Enterprise Centre in Norwich, it still takes an enlightened approach from a local council to build houses to passive house levels in an era of drastic budget cuts. At Broadland District Council, chief executive Phil Kirby says the authority was determined to lead by example. "We did compare the cost of meeting passive house standards at Carrowbreck with more traditional methods and, of course, it was more expensive. But one of our key ambitions is environmental excellence and we took the view that we wanted to pilot the production method, rather than simply maximising profit. It was also an element in attracting purchasers."

Broadland District Council went into partnership with NPS Group, the parent company of Hamson Barron Smith, to create a joint venture company, Broadland Growth Limited, which focuses on small, high-quality developments with excellent energy efficiency. For Carrowbreck, Broadland District Council provided the land and part-funded the development, but the council has been paid back with a profit. "Broadland is a big growth area and we have shown how it's possible to build an energy-efficient development and make a profit," Kirby says.

There are two much larger passive house developments in the pipeline now. The Regeneration Company, which was established by Norwich City Council to deliver new homes, is behind a 172-unit development at Three Score, in Bowthorpe, Norwich. Some 112 of the properties will be built to the passive house standard and one third of the homes will be affordable housing. RG Carter is again the contractor, having acquired a good understanding of passive house construction on Carrowbreck. A further 105 passive houses are planned at Goldsmith Street, off Dereham Road. "There's been a sea change of attitudes in Norwich," says Jackie Richards. "With all the upskilling of local tradespeople, there's an opportunity for the region to do it again and again now."

CONSTRUCTION IN PROGRESS

(from top) this sequence shows the construction of the ground floor and external walls, with the installation of the 300mm Dow Floormate EPS insulated foundation system, with 200mm of reinforced concrete above this, and the rising 300m Porotherm clay block walls forming the external walls for the properties.

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SELECTED PROJECT DETAILS

Client: Broadland Growth Limited
Architect: Hamson Barron Smith
Contractor: RG Carter
Poroton blocks: Porotherm
Airtightness products:
Pro Clima / Ecological Building Systems
External wall insulation: Baumit
Additional wall insulation: Kingspan
Cellulose insulation:
Warmcel / Payne Insulation
Additional roof insulation: Rockwool
MVHR designer: Greenwood
MVHR systems: Edmunson Electrical
Windows & doors: Ecohaus Internorm
Slab insulation: Dow
Thermal breaks: Foamglas
Roof structural components:
Metsa Wood
External blinds: Hallmark
Monitoring system: Tensor
Wall ties: Ancon
MVHR duct insulation: Armaflex

Architect's comment

The sustainability ambitions at Carrowbreck permeate the project at every level, from the overprovision of affordable homes to the new woodland path and animal haven, through to the choice of natural and low carbon materials across the site. A fully sustainable drainage strategy has been delivered and all homes have electric car charging points, rainwater butts, connection points for PV, and are compliant with the recommendations of the National Housing Standards Review. Sustainable transport choices have been supported through the new path to the closest bus stop and the shared surface access road through the development.

Carrowbreck was one of the first UK projects to use 300mm precision-engineered Porotherm blocks, a fast, virtually dry construction. With its rapid daily output, this brought cost and timesaving benefits, while its thermal and acoustic efficiencies will bring further advantages for decades to come with a design life of over 150 years.

The blocks were combined with a brand new external wall insulation to the UK market, Baumit OpenTherm, the only EPS insulation system to be truly permeable, allowing the walls to breath. Paired with lime plasters and MVHR it ensures perfect indoor humidity. The external render, also vapour open, is microscopically smooth, creating a self-cleaning surface –important on this wooded site.

Although no longer a regulatory requirement, the RG Carter project management team produced a site waste management plan for the project to reduce, reuse and recycle wherever possible. Meanwhile 11 local apprentices were employed in a range of trades to further their education and in particular the skills required to build passive house dwellings.

Carrowbreck Meadow demonstrates that in a period where affordable housing requirements are being challenged due to the introduction of the community infrastructure levy and viability issues, the council can deliver its own high quality housing developments which exceed affordable housing requirements and deliver sustainable buildings while still delivering profit.

CONSTRUCTION IN PROGRESS

(above, clockwise from top left) Airtightness detailing in preparation for floor joists; and at the wall-roof junction, ready for internal lime parge coat to complete the line of airtightness; penetrations through the airtight layer kept to a minimum and where necessary carefully sealed; the Baumit OpenTherm EPS external insulation being applied to the Porotherm walls; the OpenTherm EPS installed with fixings and trim; external render applied to the EPS.

CERTIFIED PASSIVE HOUSE COMPONENTS:

DESIGNER WINDOWS AND FRONT DOORS

FRAMELESS GLAZING.

Josko has been a pioneer of all-glass systems since 2004. With FixFrame Blue Vision, Josko sets a new architectural standard in terms of performance, aesthetics and versatility. FixFrame Blue Vision offers an uncompromising, truly framless design that allows for full-height solutions and passive house-grade thermal insulation (U_w as low as 0.59 W/m²K) and weather tightness. FixFrame Blue Vision is optimized to be combined with other Josko products, such as lift-and-slide-doors, fixed elements or front doors. When it comes to avantgarde design, it is the details that set you apart.

FRONT DOORS.

Josko front doors come in a multitude of designs and many types of exterior and interior surfaces which all feature excellent security and thermal insulation performance. Since the 1990's Josko has always been a European pioneer in developing and manufacturing front doors with flush design.

Nevos has been awarded the Passive House certificate from the Passive House Institute in Darmstadt, Germany, which was set up by Dr. Wolfgang Feist (certificate refers to doors without side section).

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WINDOWS & DOORS

(above, left to right) a layer of Foamglas Perinsul blocks in the Porotherm clay-block walls, acting as a thermal break where the balcony will meet the external walls; low thermal conductivity fixings for the external insulation; external insulation lapping over the window frames to minimise thermal bridging psi values (all windows and doors open inward).

IN DETAIL

Building type: 8 detached and 6 semi-detached homes. Sizes range from 72 sqm to 133 sqm.

Location: Hellesdon, Norwich

Completion date: October 2016

Budget: £2.8m including all construction and landscaping

Passive house certification: Certified

Space heating demand (PHPP): 13.86 kWh/m^2/yr (avg over 14 homes)

Heat load (PHPP): 10.36 W/m^2 (avg over 14 homes)

Primary energy demand (PHPP): 110 kWh/m^2/yr (avg over 14 homes)

Environmental assessment method: Code for Sustainable Homes – level 4 for water

Airtightness (at 50 Pascals): 0.45ACH (avg of pressurisation and depressurisation over the 14 homes)

Energy performance certificate (EPC): Exact figure varies by plot but all have an EPC of B.

Heating bills: Estimated at £27-55 per year, subject to house type and size, based on PHPP calculated space heating demand ranging from 832-1663 kWh/yr, and gas price of 3.68p from the Gas Collective Fix December 2016 tariff (British Gas).

Thermal bridging: Foamglas Perinsul blocks used, one course at terrace to separate parapet walls up to first floor, and under all of the ground floor door thresholds

Form factor: Averages 3.7 across the site, but varies from 3.1 to 4.3. Although larger than the market would typically provide in Britrain, the homes are relatively small compared to German homes, meaning they have a higher surface area to volume ratio than would be ideal from a PHPP perspective.

Overheating: 0-1% above 25C, based on Peter Warm's overheating stress testing.

Ground floor: 150mm compacted base followed above by 25mm sand blinding, 1mm DPM, 300mm Dow Floormate 500-A EPS insulated foundation system, separating layer, 200mm reinforced concrete (450mm wide x 935mm deep ring beam at perimeter), power-floated finish. U-value: 0.113 W/m^{2}K

Rendered walls: 220mm Baumit EWI OpenTherm Contact EPS system fixed to 300mm Wienerberger clay Porotherm block single leaf system (supplied via Ridgeon's) using Ejot fixings (Ejotherm STR U2G). Porotherm blocks laid on a mortar bed. Taped on inside with pro clima tapes to floor slab and to all junctions, roof to wall plate etc. Wet plastered internally with 20mm Baumit KP36W spray applied airtight layer, top coat of Baumit Fino Bello finishing plaster coat, sanded to finish. U-value: 0.104 W/m^{2}K

Timber clad walls: 32 x 175 sawn feather edge Siberian Larch cladding with Celcure ACT brown treatment to UC3 and one coat of black priming from Ridgeon's. Timber clad elevations feature 140mm Kingspan Kooltherm (2 layers of 70mm insulation adhered on, battened on to the Porotherm blocks. Fischer SXRL 10 x 260mm long fixing the battens to the Porotherm blocks). U-value: 0.110 W/m^{2}K

Roof: Metsawood thin joist system. 400mm I joist roof rafters, pumped full with Warmcel insulation. On the underside, 18mm OSB3 as airtight layer. Service void with 25mm battens and Rockwool RWA45 insulation. Top layer of the rafter was 15mm OSB (not as airtight later). Wall plates were a Metsawood Kerto 75mm bonded timber bedded on top of Porotherm blocks. Gyproc plasterboard finishes to ceilings. Breathable roofing felt, 38mm counter batten vertically, 25mm tile batten. Forticrete Gemini tiles externally. U-value: 0.091 W/m^{2}K

Windows & doors: Internorm KF410 passive house certified uPVC/alu units by Ecohaus Internorm. Window glazing Ug Value: 0.51-0.54, g-Value – 59-62%. Window frame Uf Value – 0.85 W/m^{2}K. Window spacer Psi – 0.031. Internorm front doors U-value 0.58 W/m^{2}K. Window installation Psi range from 0.011 to 0.109 depending on whether there are external blinds and by facade cladding.

Heating system: Vaillant Ecotec 412 system gas boiler with Santon Premier Plus PP210B cylinder in larger houses and Vaillant Ecotec Plus 32 kW combi boilers in smaller houses. Stelrad radiators in landing, kitchen/dining rooms, lounges, and heated towel rails in bathrooms.

Ventilation: Paul Novus 300 MVHR in larger houses, Zehnder ComfoAir 200 Luxe in smaller houses. With Comfotube distribution systems. Both units Passive House Insittute certified.

Water: Restricted waterflow showerheads. Water butts in gardens.

Brise soleil: Bespoke timber brise soleil designed by the architects. 150mm x 50mm C24 graded redwood spruce with chain of custody certification, with clear Protim 3A treatment and Sikens sealant stain.

RADICAL RETROFIT TRANSFORMS

PENNINES HISTORIC BARN

This ambitious experimental retrofit of a Victorian barn high in the hills of West Yorkshire has turned a cavernous, draughty space into a comfortable low energy period home — and cut its heating bills by over 80%.

by Kate de Selincourt

"While banging wind kills these stubborn hedges,
Thumbs my eyes, throws my breath, tackles my heart, And rain hacks my head to the bone..."

- The Hawk in the Rain, Ted Hughes, 1957

The late poet Ted Hughes grew up in West Yorkshire, and wrote vividly about the area's animal life – and its weather. Winter in the Pennines can be pretty remorseless, so this Victorian barn, perched 300 metres up on an exposed West Yorkshire hillside, was not the easiest building to make into a cosy, low energy home. The first builders who tried failed dismally.

A bog-standard conversion in the early 1990s had left the barn's original solid walls (faced with dressed stone but with a rubble core) uninsulated and draughty. There was a cavity-walled extension whose nod to insulation was a cursory 30mm backing of polystyrene in the cavity, on the blocks forming the inner leaf. Roof insulation was minimal, and the house was draughty and sieve-like (with very poor airtightness of 16.9 m^3/m^2 hr at 50 Pascals).

Owners Sue and Paul moved to the barn, near Cumberworth, about 17 years ago, and they love the location with its isolation and its views – but they have known for a long time that something would have to be done about its energy performance.

"It just wasn't possible to make it warm, it always felt freezing," Sue recalls. "Even to keep just a few of the rooms at around 18C cost a fortune. The heating was on all the time so we were spending something like £3,500 a year on LPG, and lighting the wood-burner every day, but we were still not comfortable – it was a nightmare. The roof and the new extension were supposed to have insulation in but it was so cold, we knew it couldn't be right."

Closer investigation showed how poorly the conversion had been carried out: "There was just one layer of loft roll, the thin stuff, and a layer of plaster between us and the outside air. What idiot built a house like this in an exposed part of Yorkshire? The heat was just going straight out of the walls and ceiling. We were basically heating the county!"

Sue and Paul were fortunate enough to have the capital resources to undertake the drastic improvements required. But they faced another common obstacle which holds

Building: Radical deep retrofit to 174 sqm Victorian barn with 1990s extension

Location: Cumberworth, West Yorkshire

Method: internal wall insulation, new floor & roof insulation, airtightness works, heat recovery ventilation

Completed: October, 2015

Energy bills (space heating): Cut from £2,522 to £461 per year

even able-to-pay building owners back from undertaking deep retrofit: they needed to find a builder they could trust to get it right.

"One of the first problems we decided to fix was the windows, as they were rotting and rain was blowing in. We were looking for a high performance eco-friendly window – I don't like uPVC – and we decided to spend out on decent windows from Green Building Store. We were so impressed, both by the thoughtful design of the windows, which ensured the rain was taken away from the wood and didn't pool next to the glass, and also by the way they were just so careful and precise carrying out the installation."

Green Building Store also solved a longstanding water penetration issue, by diagnosing two missing cavity trays. "They actually thought about what the problem was, the previous builders just slapped on a bit more flashing and went away," Sue says.

"We realised that at long last we had found a builder who knew what they were doing, and we could be confident and trust to let them go ahead with the whole renovation. Finding somebody like that is like finding gold."

The first priority of the retrofit was comfort: insulation and airtightness would be key. Putting a lid on rising bills was also crucial, and the clients also wanted to reduce dependence on fossil fuels and cut their carbon footprint: first by saving energy, and

Photos: Iain Richardson

second, by generating as much as possible of their remaining energy needs on site.

Although the house was superficially in good order and structurally sound, attempts to tackle ongoing issues with the plumbing had left numerous holes in the walls and ceilings. The layout upstairs was very poor, with two separate staircases, and one room only accessible by crawling in on hands and knees, so a full retrofit offered the chance to completely remodel the top of the house.

The boiler was on its last legs, offering the opportunity to switch away from LPG and install a ground source heat pump powering underfloor heating, which would entail digging up the solid floor. Lastly, the house had a cesspit — very expensive as water ingress meant it needed frequent emptying, so Sue and Paul decided to replace it with onsite wastewater treatment.

Although they had initially hoped the retrofit could be carried out in two stages, while they remained in situ, it soon became clear that it would be a great deal easier if they gave Green Building Store a clear run at the house, so they moved out to a small rented cottage nearby.

Experimental insulation strategy

As a traditional stone building, the house was unsuitable for external insulation – the planners would not have been happy – so a safe internal insulation solution was required.

Overall, although of course the ultimate aim of the retrofit was to save energy, the design team had to prioritise condensation risk, as there is no point in having a lovely warm house that is going mouldy.

Solid walls pose a particular problem with internal insulation. The insulation makes the masonry colder, and potentially slows the drying out of trapped moisture in the wall. These risks are reduced if the insulation value is not too great, and if the system is vapour-open and capillary active, so that moisture can escape from the wall inwards as well as outwards.

Potential moisture risks here were several, including driving rain penetrating the exposed west walls, damp from groundwater soaking inwards and upwards (the solid walls had no damp proof course, and with the rubble interior, retrofitting one was impossible), and interstitial condensation from internal moisture.

While tricky, this is not an issue that can be avoided. As Bill Butcher of Green Building Store says: “In many ways, thinking about the best ways to install internal wall insulation is at the cutting edge of sustainable building in the UK. External wall insulation is not a viable option for many buildings in the UK and so we need to get to grips with how we use internal wall insulation effectively and safely.”

For the solid walls here, Green Building Store decided to trial an insulation system called TecTem (which is not currently sold in the UK) based on perlite insulating blocks, which are made from volcanic glass. TecTem was chosen as it is capillary active and vapour open, but biologically inert and quite alkali, therefore relatively mould-resistant (more so than wood-fibre). “We were very pleased to find the product as water penetration was such an issue here, with the stone and the location,” Butcher says.

Nevertheless, Green Building Store wanted to be as sure as they could that the system would perform properly, so they had dynamic moisture simulations carried out using Wufi software to predict the way the insulated walls would behave over time. To give enough accuracy, the stone in the walls was tested for moisture permeability using Karsten tubes.

The extension walls were not such a moisture risk, as the outer stone leaf effectively forms a ventilated rain screen, so a cheaper internal insulation build-up with insulated studs supporting vapour-open mineral fibre behind an intelligent membrane was used.

The Wufi modelling predicted that the chosen systems would be safe. The team were also pleased to learn that the extension walls were predicted to remain sufficiently dry enough even with the gypsum plaster retained behind the insulation (gypsum has a higher mould risk relative to lime) – so it did not have to be hacked off and replaced.

Before applying the internal insulation to the old, solid walled section, the floor joists were moved away from the external wall and the walls were parged to help minimise wind-driven moisture and provide a smooth surface. Water inhibitor was added to the bottom 900mm of the walls to inhibit rising damp. The east wall is particularly damp at the bottom, so Foamglas slabs were used as an impervious tanking and insulating solution here.

TecTem was quite tricky to use, Bill Butcher reports, because it is relatively soft and friable, though this makes it easy to cut to size when required. It is supplied with its own installation system — pretty similar to those used for external insulation, including a levelling coat, adhesive, filler, a textile mesh layer and finishing plaster/render. The uneven surface of the Victorian stone meant a lot of levelling was required, entailing several re-orders.

Because TecTem was an unfamiliar product that was being used in a relatively risky location, Green Building Store jumped at the chance to participate in a research project to monitor the walls post-retrofit. In partnership with Simmonds Mills Architects, 54 moisture ▶

and temperature sensors were installed around the house, throughout the thicknesses of the walls, and at the joist ends.

So far the monitoring results indicate the walls are performing well, with moisture levels slowly reducing, as the insulation reduces the moisture condensing on and soaking into the wall from the inside, while allowing the existing moisture to slowly dry out, with the help of the ventilation system.

Insulating the reveals is critical to the performance of solid wall insulation: uninsulated reveals in walls treated with internal insulation represent a significant thermal bridge and even worse, pose a major threat of condensation and mould.

The window openings at the Cumberworth barn were relatively small and furthermore, Green Building Store triple-glazed windows had already been installed, so a very thin insulation was required for reveals. The team splashed out on vacuum insulated panels (VIPs), as the insulation value of a thin enough sliver of standard insulation would have been too poor. VIPs were also used against the external wall behind the stair string, so that the stairs did not have to be rebuilt.

VIPs are not without their problems — and not just with the price. They are highly vulnerable – if they are cracked, or punctured by a nail or screw, air will rush in and the insulation value will be much reduced. While the current occupants know that they can't, say, hang blinds in the window openings, there is always the concern that this message might not be grasped by future occupants.

As much insulation was fitted into the roof — up to 350mm -- as the limited headroom would allow, between and below the timbers. Meanwhile the ground floor was excavated to 450mm in order to include a concrete subfloor, 200mm of insulation, and an underfloor heating slab.

Thermal bridging was avoided by surrounding the heated slab with an insulation upstand to meet the wall insulation – which in turn meets the roof insulation. There was also a thermal bridge where the old gable end wall, now an internal partition wall, cut across the internal insulation to join the external wall. The impact of this thermal bridge was reduced by continuing the internal wall insulation around the corner and about 400mm inwards, along both sides of this partition wall.

CONSTRUCTION IN PROGRESS

(clockwise from top left) 10mm of Kevothermal VIP insulation at window reveals to minimise thermal bridging here; airtightness measures in the roof include a continuous Intello membrane with taped joints; the existing barn's solid walls were insulated internally with 100mm Knauf TecTem perlite insulation; use of Foamglas Perinsul blocks to minimise thermal bridging at the end of a steel beam; TecTem internal insulation around window opening to the old masonry walls; TecTem was used to minimise thermal bridging by continuing the insulation layer 'around the corner' where an original gable wall, now an internal partition wall in the revamped house, meets a new external wall (fitted out internally with mineral wool insulation and Intello membrane)

Airtightness

In such a windy location, airtightness was crucial to comfort and performance. The airtightness layer for the solid walls was the internal parge, with all penetrations and joints taped. For the cavity wall, airtightness was provided by an Intello Plus membrane inside the mineral fibre insulation (Intello Plus was also used in the roof), and on the whole this strategy was very successful.

However, air testing after the retrofit was complete showed the building had two major leakage points. One was the wood-burning stove, which despite being a specially procured 'passive' model, leaked around one air-change-per-hour (at 50 Pascals) all on its own. Replacing it with a modified Morso S11 stove largely resolved this issue.

The second issue was more frustrating: thermal imaging during air testing showed ingress of cold air through the stone fabric of the solid internal parition wall (at the gable end of the original barn), via the exterior masonry. Outside air was entering the outside walls, passing sideways through the rubbly masonry and entering the room.

"Given that the rest of the building — except the stove, which we accounted for separately — was so carefully done and showed no detectable leaks at air test, we were pretty sure that this one partition wall actually accounted for around one extra air-change-per-hour loss of airtightness," Bill Butcher says, and he is frustrated that the team did not anticipate the problem. "In hindsight we realise we should have wet plastered the wall and taped the joist ends into the parge, or cut them and hung them from the wall," he says.

Green Building Store has now invested in their own air blower to spot anything like this at an earlier stage.

Building services & renewables

Sue had long been attracted to the idea of using a heat pump to capture heat from the environment and cut fossil fuel use. "We have a large field below the house that is very boggy and never freezes, making it an ideal heat source for a ground source heat pump – and being off the gas grid made the decision to switch easier," she says.

CONSTRUCTION IN PROGRESS



(above, from left) Shown here is the Solitex Plus windtightness membrane which was fitted under the roof slates, and insulated flashing around a Velux roof window; further airtightness detailing in the roof, with Pro Clima tapes around roof timbers; parging around joist ends for airtightness.

"Digging the trench was a lot of work, especially as they did it in February and it kept filling with water! They were incredibly careful and missed all our fruit trees, and I got them to dig me a wildlife pond at the same time, which I love."

The team also managed to squeeze in an MVHR (mechanical ventilation with heat recovery) system, essential in order to maintain air quality and retain heat, and fitted both PV and solar thermal panels onto the not-especially-large roof. "The roofs face east and west, so we have generation all day, from 4am to 10pm in the summer," Sue says.

The final outcome

Now that they have completed their first calendar year back in their retrofitted home, the clients can give their verdict. "It's fabulous! It's so warm," Sue says, "we absolutely love it."

The couple run the house at around a very pleasant 22C. "Before, we could never have even got it up to 21C, and if we could have, I dread to think what it would have cost."

The running cost savings are certainly dramatic. "In 2013 our running costs (LPG, electricity and sewage charges for cesspit emptying) were £6,500, that's £124 a week. In 2016, our first full year back in the house, the costs were only £32 per week. That really staggered me. We are saving £5,000 a year, and more than that even, as Paul has switched to an electric car so his travel costs are now included too."

The performance has come in pretty close to the design target: modelling in the passive house design software PHPP suggested a space heat demand of 65 kWh/m²/yr. Extrapolating back down to 20C (the PHPP design temperature) from the actual monitored fuel use at 22C, and subtracting the assumed energy consumption by appliances and hot water, suggests the space heat demand at 20C is around 69kWh/m²/yr, just slightly higher than the PHPP estimate.

While it isn't really possible to know what the average temperature or true space heating demand of the building was prior to the retrofit, looking at old gas bills and assuming the whole house was heated to 18C all the time – though in reality it was likely far lower – and that no wood fuel was used, the fabric heat demand works out at around 200kWh/m²/yr. As wood was used as well, and parts of the house were unheated — or unheatable — the original fabric energy demand could easily have been double that or more, the team at Green Building Store suspect.

Even if it had been possible to heat the house just to 20C, it would have cost anything between £500 to £1000 extra per year, or even more, to do so. Though with so many draughts, it might not have been much more comfortable.

By contrast, post retrofit, turning up the thermostat from 20C to 22C is probably only costing Sue and Paul an extra £50 or so a year. So why wouldn't they?

While deep retrofits such as this will be essential if we are to meet our ever-more-pressing carbon emissions targets, climate change is often a secondary driver for building occupants. Although Paul and Sue were indeed keen to cut their carbon footprint, first and foremost they wanted to be comfortable. And that they have certainly achieved.

Explained: Wufi is a software application that allows for realistic, dynamic modelling of the movement of heat and moisture in walls, roofs and other building elements.

SELECTED PROJECT DETAILS

Project design & management: Green Building Store
Main contractor: Green Building Store
Civil & structural engineering: SGM Structural Design
Windows & doors: Green Building Store
Roof windows: Velux
Heat recovery ventilation: Green Building Store
Airtightness products: Pro Clima from Green Building Store
Internal wall insulation: Knauf (TecTem)
Ground source heat pump: Green Source Heat Ltd
Solar Thermal & PV: EcoHeat Ltd
Decorating: GB Decorating

SPACE HEATING DEMAND SCENARIOS	Fuel	Heating system	Notional internal temperature	kWh(m²/yr heat required	£/yr fuel required	kg CO_2/yr emitted
Original house actual use (Substantial log burning not included)	LPG	boiler	Unknown - well below 18C	186	£2,522	6960
Predicted retrofit	Electric	Ground source heat pump and solar thermal hot water	20C	65	£384	1189
Reduction				**65%**	**85%**	**83%**
Actual retrofit	Electric	Ground source heat pump and solar thermal hot water	22C	78	£461	1429
Reduction				**58%**	**82%**	**79%**
Actual retrofit (Estimate with adjusted temperature)	Electric	Ground source heat pump and solar thermal hot water	20C	69	£409	1267
Reduction				**63%**	**84%**	**82%**

Energy, cost & CO_2 savings from fabric & services improvement, courtesy of Green Building Store

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> IT JUST WASN'T POSSIBLE TO MAKE IT WARM BEFORE, IT ALWAYS FELT FREEZING.

When do you need to do Wufi condensation analysis on a building?

The answer is – probably more often you think. While many designers are starting to question previous practice, the official guidance, which has been inadequate for a long time, is still trying to catch up.

Last summer, an important caveat was added to BS 5250, the British Standard for control of condensation in buildings, on which much else, including aspects of product certification, is built. The standard is also referenced in Part C of the Irish building regulations, which deals with resistance to moisture.

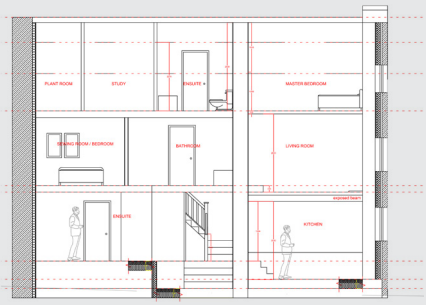
New tables have been introduced which hopefully clarify the recommended assessment methods (ie either linear or dynamic) for different types of floors, walls and roofs. The British Standards Institute (BSI) also adds what could be seen as a 'holding position' on vapour control layers, stating: "The addition of a vapour control layer (VCL) inside internal insulation (IWI) on solid walls was regarded as essential. However it is now agreed that, in many cases, this may cause more harm than good. The revised guidance in G.4.1.4 essentially says 'be careful' and consider all the issues when installing IWI. Work to clarify these issues will continue for the full revision of BS 5250."

BSI says it has taken the "knowledge of the problems caused by moisture in buildings [which] has advanced rapidly since BS 5250 was last revised in 2011," into account in their update of PAS 2030 – the certification standard required of installers, should they find themselves in receipt of ECO funding to install solid wall insulation. The standard now says a great deal more about moisture risk and also the need for ventilation than the previous version. However ,it is not yet clear if enforcement will be stepped up to match.

Pending the full reviews of BS 5250 and Part C of the building regulations in England (which again deals with moisture protection, and is currently under review separately), designers should beware using solid wall insulation techniques without condensation analysis, even where these have been deemed perfectly acceptable even in the recent past. Things have gone badly wrong in some instances, and designers, suppliers and installers have all been caught out.

Some insulation suppliers will give detailed advice on the suitability of their system for a particular setting, and some even perform Wufi simulations for their customers. However, Wufi modelling is not a get out of jail free card: in particular, the reliability of the results depends critically on the accuracy of the fabric properties fed into the calculations. So — especially when a wall seems to be in poor condition, damp, porous or even just unusually thin, it is probably as well to get some sums done first — rather than be sorry later.

IN DETAIL



Building type: 4-bed semi-detached house, incorporating Victorian barn (converted in 1990s) and 3-storey 1990s extension

Location: Cumberworth, West Yorkshire

SPACE HEATING DEMAND (PHPP)
Before: 497 kWh/m²/yr
After: 65 kWh/m²/yr

HEAT LOAD (PHPP)
Before: 242 W/m²
After: 27 W/m²

PRIMARY ENERGY DEMAND (PHPP)
Before: N/A
After: 78 kWh/m²/yr

Energy performance certificate (EPC): N/A

MEASURED SPACE HEATING DEMAND
Before: 176 kWh/m²/yr
(not counting substantial use of logs, badly heated at temperatures under 18C)
After: 78 kWh/m²/yr
(22C, monitored Dec 2015 to June 2016)

ENERGY BILLS
Before: £2,522 per annum
After: £461 per annum

AIRTIGHTNESS (AT 50 PASCALS)
Before: 16.9 air changes per hour
After: 2.0 air changes per hour

WALLS (BARN)
Before: Victorian barn with inner and outer stone facing, filled with rubble and the occasional through stone. Original wall U-value: 1.11 W/m²K.
After: Parge coat, weak sand and cement coat to original wall (with water inhibitor for the bottom 900mm), followed inside by 100mm TecTem vapour and capillary open IWI made from perlite (lamda value 0.045); plaster skim. U-value: 0.36 W/m²K

WALLS (EXTENSION)
Before: 1990s cavity wall construction with 30mm poly-back insulation (not continuous). Original Wall U-value: 0.992 W/m²K.
After: Existing gypsum plaster patched with parge coat, weak sand and cement coat, followed inside by insulated studwork, 95 mm mineral wool insulation (lambda value 0.032); Intello Plus vapour open airtightness membrane, service void, plasterboard and skim. U-value: 0.28 W/m²K

ROOF (BARN)
Before: Roof slates, minimal 100mm insulation. U-value: 0.487 W/m²K
After: Solitex Plus windtightness membrane under roof slates, taped with Tescon No.1, followed inside by 350mm mineral wool quilt (lamda value 0.040); Intello Plus airtightness membrane, 50mm polyurethane insulation, plasterboard and skim. U-value: 0.10 W/m²K

ROOF (EXTENSION)
Before: Roof slates, minimal 100mm insulation. U-value: 0.487 W/m²K.
After: Solitex Plus windtightness membrane under roof slates, taped with Tescon No.1, 200mm mineral quilt (lamda value 0.040); Intello Plus airtightness membrane, 50mm polyurethane insulation; plasterboard and skim. U-value: 0.15 W/m²K

FLOOR
Before: 1990s concrete slab with insufficient insulation. U value: 0.720 W/m²K
After: 100mm concrete slab, followed above by damp proof membrane, 200mm Xtratherm polyurethane insulation, polyurethane upstand at edge of the floor ensures continuity of insulation with internal wall insulation, 75mm screed with underfloor heating, ceramic tiles. U-value: 0.10 W/m²K

Windows & doors: New Green Building Store triple glazed FSC-certified timber windows and doors. Overall U-value of 0.90 W/m²K — installed a few years prior to full retrofit. 10mm of Kevothermal VIP insulation (lamda value 0.007) was added to window reveals during the retrofit to minimise thermal bridging.

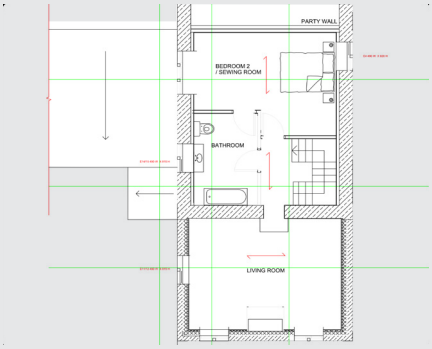
Roof windows: Velux triple glazed timber roof windows with insulated flashing. Overall U-value: 0.83 W/m²K

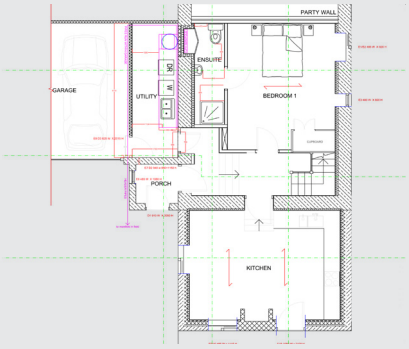
HEATING SYSTEM
Before: LPG gas heating and solid fuel fire
After: Ground source heat pump system feeding into underfloor heating on ground floor and panel radiators in the top two floors. Ground source heat pump: Kensa high temperature single compressor H062-S1H, with a nominal output of 6kW at a ground temperature of 0C and a heating flow temperature of 3C. At these operating temperatures it has an efficiency of 417% (COP of 4.17). This model is able to reach an output temperature of 65C which allows it to heat the hot water cylinder without the need for an immersion heater although one was provided as a backup. COP at 65C output is 2.08. Plus Morso S11 wood burning stove and 3.9 sqm solar flat plate array supplying domestic hot water.

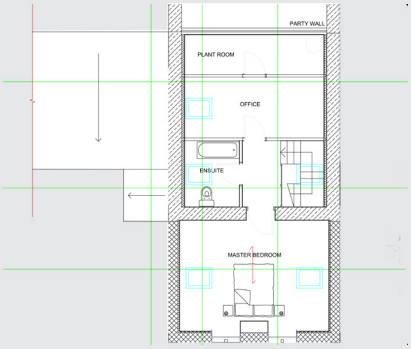
Electricity: 7 x BP 4175 mono crystalline solar PV modules. System size: 1.225kWp.

VENTILATION
Before: No ventilation system. Reliant on infiltration, chimney and opening of windows for air changes.
After: Paul Novus 300 heat recovery ventilation system — Passive House Institute certified to have heat recovery rate of 93%.

Green materials: TecTem internal wall insulation, made from perlite volcanic glass, Little Greene low VOC emulsion (to ceiling), Aglaia & Auro ecological paints, Little Greene low-solvent eggshell paint to woodwork.







WANT TO KNOW MORE?

The digital version of this magazine includes access to exclusive galleries of architectural drawings.

The digital magazine is available to subscribers on www.passive.ie

Building type:
217 sqm timber frame house
Standard:
nZEB / uncertified passive house
Location: Kilbride, Co Wicklow
Completed: 2013
Budget: £250,000
Heating: Air source heat pump
BER: A2
Heating bill:
€70-103 per year (estimated)

THE HOUSE THAT COSTS

€70 A YEAR TO HEAT

Designed around an existing timber chalet, this striking contemporary house managed to go passive on a budget for one lucky family of six, all while inadvertently blitzing Ireland's forthcoming nearly zero energy building standard.

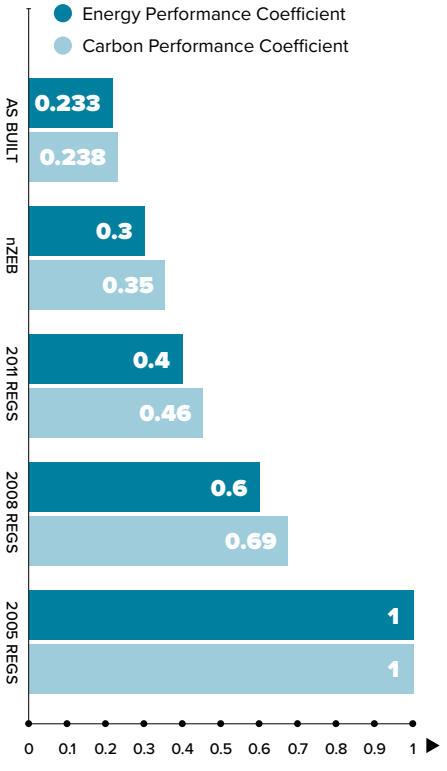
by Lenny Antonelli

> THE BIGGEST CHALLENGE ON SITE WAS PROBABLY WORKING AROUND AND RETAINING THE EXISTING CHALET.

Photos: Peter Grogan / Emagine.ie, Tomasz Juszczak / Imageworks

Explained:

The ***Energy Performance Coefficent (EPC)*** and ***Carbon Performance Coefficient (CPC)*** measure the energy and carbon efficiency of buildings under the Irish building regulations. Here we compare the EPC and CPC for this dwelling to Ireland's proposed nZEB standard and to the current (2011) and past versions of Part L of the Irish building regulations. The lower the fraction, the better the score - so for instance a house with an EPC of 0.4 is 60% better than the 2005 regs.



Sitting outside Kilbride in Co Wicklow, this contemporary family home has very much kept it in the passive house family — homeowner Aine Dowd is the sister of Passive House Academy founder Tomás O Leary, and the house was designed by their brother Cathal's architecture practice OLS.

Naturally Aine and her husband Frank spent some time in Tomás's own Wicklow passive house — Ireland's first, built way back in 2007 — before choosing to aim for the standard on their own build.

"When we visited him we loved the draught free comfort and heat in his home," says Frank. "A turning point was staying over one snowy night and waking in the middle of the night to find the house as warm then as it had been earlier in the evening."

But with their own greenfield site to build on, what did he want from a family home? "We had a beautiful site and we wanted to maximise our views. We also wanted a fuss free functional home, with room for ourselves and four growing teenagers."

In order to achieve planning permission, an original timber chalet on the site had to be retained. OLS achieved this by elegantly incorporating it into the design of the new dwelling, signified by the timber facade, which makes for a neat contrast with the new, rendered surfaces.

"The biggest challenge on site was probably working around and retaining the existing chalet while at the same time achieving the passive house standard," says architect Cathal O'Leary.

This building is far removed from the sort of compact, box-like forms that make it easier to meet the passive house standard. The old chalet determined the location and orientation of the new home, which faces south-west. However, this orientation has led to some overheating inside on summer evenings – a problem which was flagged at design stage in the PHPP calculations.

OLS did design a brise soleil to shade this elevation, but it has yet to be installed.

"We generally do not use internal or external blinds for reducing overheating in our PHPP calculations as the majority of people want to look out into their gardens on the few sunny days we get," says architect Cathal O'Leary. The lack of brise soleil means that the house is more subject to the good and bad aspects of passive solar gains. While the space heating demand as designed was a miniscule 15 kWh/m^2/yr, the absence of the intended external shading has dropped that down to just 11 kWh/m^2/yr. But it comes at the cost of overheating: the house is calculated to exceed 25C for 11% of the year, compared to 4% if the brise soleil was in place.

The house is of timber frame construction, clad externally with blockwork, and insulated with both mineral wool from Knauf and rigid PIR boards from Kingspan

(above) A Danfoss air to water heat pump, consisting of an outdoor collector unit (left) and indoor unit with 180 litre cylinder (right), supplies heat to the house via an underfloor heating system; (below) homeowners Aine & Frank Dowd relaxing in their garden.

> ON COLD DAYS, THE CONDENSATION IS ON THE OUTSIDE OF THE WINDOWS.

insulation boards. The roof is of similar construction, and the whole house is heated by a Danfoss air-to-water heat pump that supplies underfloor heating.

Impressively, the finished house manages to be both visibly contemporary but not too flashy, with the tidy form and low profile crouching behind trees on the site.

So what is Frank's verdict, having lived in the house for four years? "We love the level of comfort in the house. We maintain a constant temperature throughout the day and we have no draughts or cold rooms. On cold days, the condensation is on the outside of the windows."

Having both a heat pump and mechanical ventilation unit does mean their electricity bills are slightly higher than before, he says – a fact which is bound to owe much more to the domestic hot water needs for a family of six than the combined heating and ventilation needs of such a low energy building.

"But we don't have any other fuel bills so overall it is far more cost-effective every year than our old house."

Architect's comment

The design is a play on square and rectangular "volumes" using the existing chalet square footprint to determine their locations. Each geometry forms separate functional spaces which are further defined by the introduction of split floor levels to create higher floor to ceiling heights in the open plan living, dining and kitchen areas.

The existing chalet accommodates the kid's bedrooms with the remainder of the accommodation in the new "extension" which is orientated to the south west. Part of the south west elevation is set back to break up the elevation, which allowed us to introduce windows to the northwest and southeast of the living and master bedroom blocks respectively. By introducing windows in these locations we managed to introduce a cascading effect which helps to visually link the various volumes, and gives the overall house design a cohesiveness.

SELECTED PROJECT DETAILS

Clients: Aine & Frank Dowd
Architect: O'Leary Sludds Architects
Civil & structural engineer: Gerry Higgins & Associates
Main contractor & electrical contractor: TOC Construction
Mechanical contractor: Heat Doc
Airtightness tester: Greenbuild
Indicative BER: 2eva.ie
Timber frame: Ramstown Timber Frame
Wall & roof insulation: Knauf
Additional wall, roof, floor insulation: Xtratherm
Airtightness products: Proline Hardware
Windows & doors: Munster Joinery
Heat pumps & underfloor heating: Danfoss, via Heat Pumps Ireland
MVHR: Versatile
Roofing: Alkroplan Roofing Materials
Breather membrane: Tyvek
OSB: SmartPly
Thermal breaks: Quinn Lite
Radon barrier: Tradecraft

HOW MUCH TO HEAT THIS HOUSE?

Unfortunately, definitive figures of the annual space heating costs for this house are unavailable. The 2013 project pre-dated the decision by heat pump supplier Danfoss to provide heat meters on their heat pumps.

But an analysis by energy consultants 2eva.ie for this article to establish an indicative Building Energy Rating sheds some light. The calculated space heating load for the heat pump is just 739 kWh per year, to deliver an output of over four times that amount of heat, thanks to a highly efficient air-to-water heat pump. Assuming a rate of €0.14 per unit, that's just €103 per year on space heating. (The fans to run the ventilation system are calculated to use 608 kWh of electricity, adding about another €85, but although heat recovery ventilation helps reduce the heating demand in passive houses, this electricity cost should arguably be regarded as a ventilation energy cost, rather than a heating cost.)

But these figures come with a major caveat: Deap, Ireland's national energy performance calculation methodology for homes, assumes temperatures of 21C in living areas and 18C in the rest of the house, which works out at an average of 18.49C in this house. And it only assumes the house is being heated to those temperatures for eight hours a day, and only during the heating season.

The passive house software, PHPP, instead assumes a whole-house minimum of 20C, 24/7, all year round. But this higher comfort assumption doesn't mean PHPP would predict higher energy use, as the two software tools calculate the building's energy demand differently. In this case, a PHPP-calculated space heating demand of 11 kWh/m²/yr corresponds to 2165 kWh per year of delivered heat. Based on the Danfoss heat COP of 4.3, that means a predicted electricity use of just 503 kWh per year. Which would mean €54 per year in heating costs.

So, taking the two calculated results and our assumed electricity price at face value, it's either €70 or an extra €30 per year – enough to subscribe to this magazine and still have change for a pint – to heat a 217 sqm home.

CONSTRUCTION IN PROGRESS

(above, from left) The ground floor features 165mm Xtratherm Thin-R insulation tightly installed with separation layer to ensure no thermal bypass and upstaged to edge of slab, with a first course of Quinn Lite B5 blocks; shown here are triple glazed uPVC units from Munster Joinery, and the Alfa Rufol Varia airtight membrane and tapes applied to the timber frame, which has Kingspan Therma insulation to the inside; a 200mm timber I-joist system creates a service void that contains MVHR ducting.

> THE FINISHED HOUSE MANAGES TO BE BOTH VISIBLY CONTEMPORARY BUT NOT TOO FLASHY.

Explained: A ***brise soleil*** is an architectural feature, such as a permanent shading device projecting horizontally above a window, designed to reduce overheating and glare by blocking sunlight.

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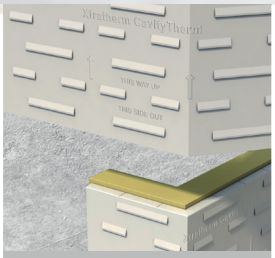
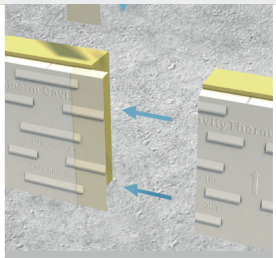
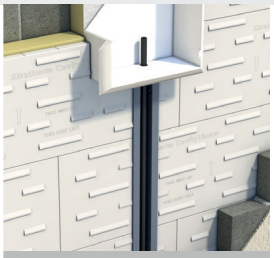


Preformed Corner Panels

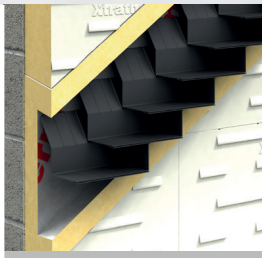
Service Void Panels



Jointing Strip



Hockey Stick Insulation



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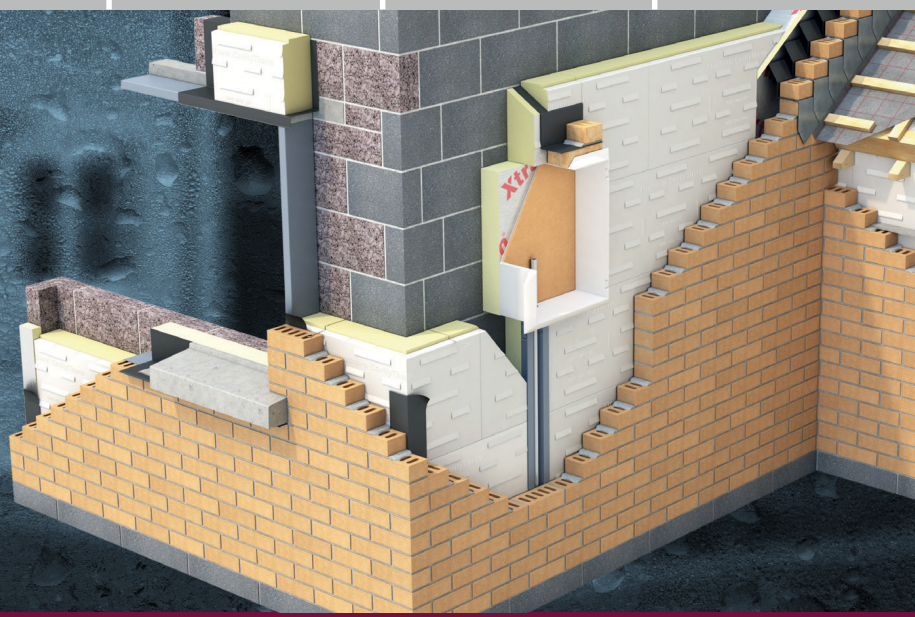

For more information contact our Technical Team

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IN DETAIL

Building type: 217 sqm detached split-level timber frame bungalow, incorporating existing timber chalet. (Treated floor area 213.48 sqm)

Location: Kilbride, Co Wicklow

Completion date: February 2013

Budget: €250,000

Passive house certification: Not certified

Space heating demand (PHPP): 11 kWh/m²/yr (without brise soleil – this would increase to 15 kWh/m²/yr with brise soleil)

Heat load (PHPP): 10 W/m²

Primary energy demand (PHPP): 93 kWh/m²/yr

BER (indicative): A2 (38.75 kWh/m²/yr)

Heat loss form factor: 3.1

Overheating (PHPP, percent of year above 25C): 4% with brise soleil, 11% without.

Space heating costs: Estimated at either €70 or €103 per year, respectively based on PHPP and Deap calculations and assuming a price of €0.14 per unit of electricity.

Airtightness: 0.54 ACH at 50 Pa

Thermal bridging: First course of Quinn Lite B5 blocks, continuous insulated timber frame envelope from window/door edge to edge, thermally broken passive house certified window. Y-value (based on ACDs and numerical simulations): 0.08 W/m²K

Ground floor: Floor finish on 150mm concrete slab with underfloor heating pipes, on 165mm Xtratherm Thin-R insulation tightly installed with separation layer to ensure no thermal bypass and upstaged to edge of slab, on Rhinoplast Ultra radon barrier, on sand blinding with traditional strip foundations. U-value: 0.13 W/m²K

Walls: External leaf of either sand & cement external render to concrete block or horizontal shiplap timber cladding to treated timber counter batten system, with 50mm ventilated cavity to timber frame construction. Timber frame construction of DuPont Tyvek house wrap wind-tight breather membrane, on 9mm Smartply OSB3 board, on 140mm structural timber frame filled with 140mm Knauf Earthwool Frametherm insulation, with 80mm Kingspan Therma timber frame insulation board fixed to the internal of the timber frame construction. Alfa Rufol Varia airtight membrane and tapes system applied to the timber frame insulation board with 40mm treated timber battens to create internal service void, with 12.5mm Gyproc skimmed wallboard internally. U-value: 0.14 W/m²K

Roof: PVC membrane roof covering system, on roof decking, on treated timber firing pieces, on breather membrane, on 250mm structural timber frame roof filled with 200mm Knauf Earthwool Frametherm insulation, with 80mm Kingspan Therma timber frame insulation board fixed to the internal of the timber frame construction. Alfa Rufol Varia airtight membrane and tapes system applied to the timber frame insulation board with 200mm timber I-joist system to create service void for ducting above 12.5mm Gyproc skimmed ceiling board internally. U-value: 0.12 W/m²K

Windows: Munster Joinery PassiV Future Proof triple glazed uPVC windows, with argon filling and an overall U-value of 0.78 W/m²K

Heating system: Danfoss AQ air to water heat pump and 180 litre cylinder, heating via a Danfoss underfloor heating system.

Ventilation: Zehnder Comfoair 350 heat recovery ventilation system with stainless steel ductwork.

389 SQM HOME

€200 MEASURED ANNUAL HEATING

This large family home in south Dublin proves that big homes don't need to be cold and draughty, comfortably beating Ireland's planned nearly zero energy building standard for 2021 — even though it was finished in 2015.

by Lenny Antonelli

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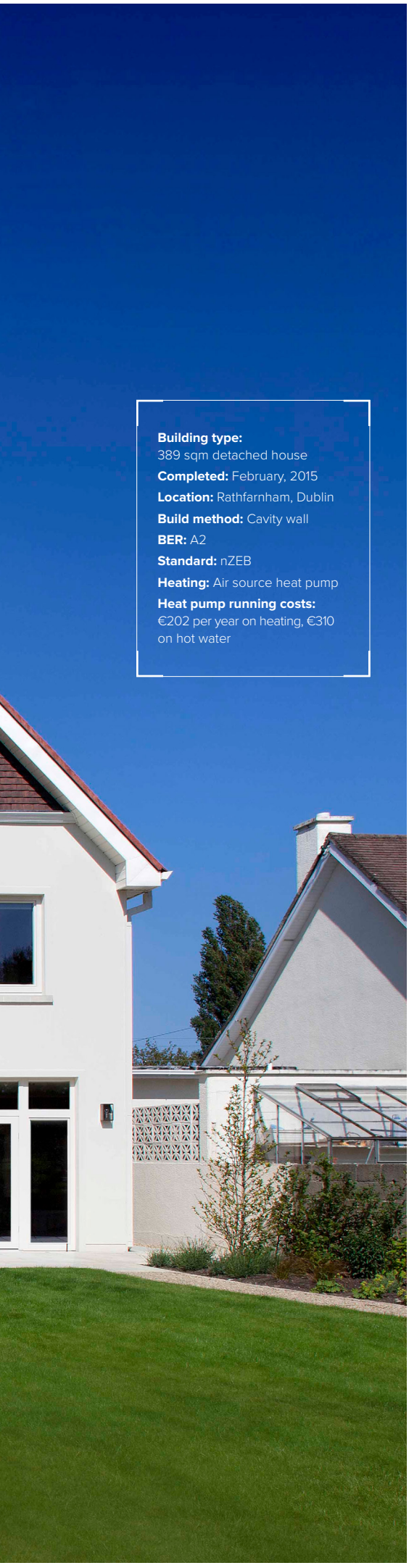


Building type:
389 sqm detached house
Completed: February, 2015
Location: Rathfarnham, Dublin
Build method: Cavity wall
BER: A2
Standard: nZEB
Heating: Air source heat pump
Heat pump running costs:
€202 per year on heating, €310 on hot water

Having lived in lots of different houses, when it came to self-building their own home Sinead and John were eager to take the best bits from all the properties they'd lived in. "For us the big thing was the possibility of living in a house that was warm and comfortable and draught free," Sinead says.

"It was about not wanting to live in a cold space — and not wanting to have to measure how much heat we were putting in. There's no point in creating lovely bright big spaces if they're also cold spaces."

Project architect Adrian Hill brought on board passive house designer Tom Byrne as energy consultant, while Sinead's husband John found leading low energy contractor Mannion Passive House Builders online, and the couple eagerly visited one of their projects. "It's great to actually walk through a house that your builder has just worked on," Sinead says.

So what did the couple want from their new family home? For one thing, they were keen to maximise views from the rear elevation, which faces south-west over a golf course. "That's where we wanted all of our big windows," she says. There are also brise soleil on the facade here to control overheating.

Architect Adrian Hill says his main task was to balance design with energy efficiency. High performance windows were essential given the large extent of glazing. The complexity of the roof, with its different elements and dormers, was another challenge — particularly ensuring it was airtight and free of thermal bridges. Thermal breaks to the steel work supporting the first floor also involved careful thermal detailing.

Sinead admits living in such a low energy house has been learning curve — from understanding how the mechanical ventilation with heat recovery (MVHR) works to why they couldn't put a letterbox in the front door (to protect the airtightness layer). "Things like that were all new to us," she says.

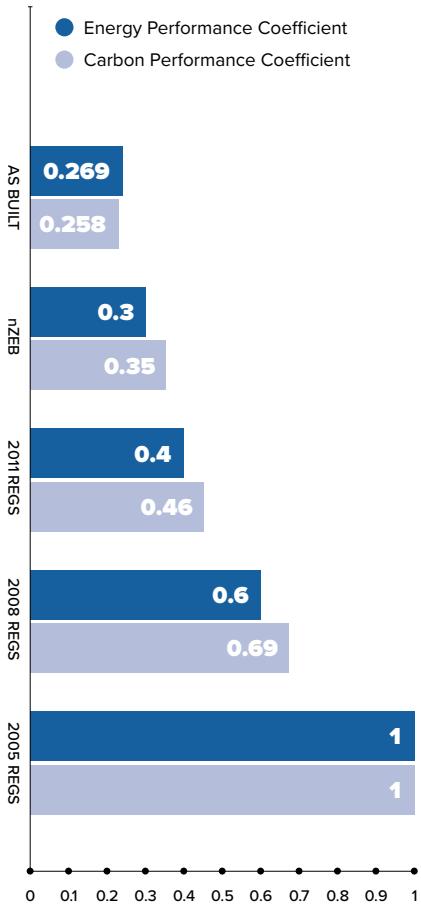
She admits to being uncertain about the MVHR at first, but says living with the constant, pre-warmed fresh air delivered by the unit has changed her mind. "It's very comfortable — it's not an issue at all," she says.

She's also happy with how the house's Nibe air-to-water heat pump is performing. "I don't even know it's there, I never have to turn it off or turn it on," she says. The system - which was installed along with underfloor heating by NGS Mechanical as part of the plumbing and heating package - consists of a 12 kWh outdoor collector and fridge-like indoor unit, complete with preinstalled hot water cylinder, buffer tank, pumps and expansion vessel, with an ultrasonic heat meter, allowing its energy performance data to be studied online via an App or PC. "The software is smart grid ready and can even interact with other renewables such as PV, and it can run the heat recovery ventilation from the same platform," said Paul O'Donnell of Nibe distributor Unipipe. The figures look remarkable for any building, let alone a 389 sqm detached house: the heat pump is using just 3.8 kWh/m²/yr of electricity to heat the house, which works out at just €202 per year. Nibe's monitoring also retains the two most recent months of temperature data – from March to May. In that time, the house hasn't once dropped below 21C, and has barely ticked over 23C.

Sinead and John also have a Heatmiser digital thermostat in the kitchen, which controls temperatures in each room (there is underfloor heating in all rooms downstairs, and radiators upstairs). There are also standalone log burning stove and gas fire ▶

Photos: Barbara Corsico & Infinity Media

> THERE'S NO POINT IN CREATING LOVELY BRIGHT BIG SPACES IF THEY'RE ALSO COLD SPACES.



Explained:* *Thermal bridging occurs when heat or cold transfers through a structure, across the external surface of a building. A common example would be where an internal floor cuts through insulation and meets the external wall of a building. A thermal break is a structure or material designed to eliminate a thermal bridge.

to individual living spaces — at 389 sqm, this is a big house, after all.

But with an energy performance co-efficient of 0.269 – meaning the building's energy demand should be no more than 26.9% of the same building if built to the 2005 building regulations – it comfortably beats Ireland's planned nearly zero energy building (nZEB) standard, which Ireland is legally bound to implement for all new homes completed after 2020.

"Actually this house is so well insulated I don't think the radiators upstairs came on at all over the winter," says Sinead. "If I come downstairs in the middle of the night, it's the same temperature as the middle of the day." ▶

SELECTED PROJECT DETAILS

Architect: Adrian Hill Architects
Energy consultant: Tom Byrne Designs
Contractor: Cyril Mannion
Mechanical contractor: NGS Mechanical
Heat pump & underfloor heating: Unipipe
Wall insulation: Xtratherm
Roof insulation: Knauf
Ground floor insulation: Kore
Thermal breaks: Farrat
Thermal blocks: Quinn Lite
Airtightness products: Ecological Building Systems
Cement screed: Kilsaran
MVHR: ProAir
Windows: True Windows
Roof windows: Velux
Wood burning stove: Lamartine
Clay tiles: Marley, via Tegral
Rainwater harvesting: Kingspan Environmental
Kitchen: Shalford Interiors

> “HIGH PERFORMANCE WINDOWS WERE ESSENTIAL GIVEN THE LARGE EXTENT OF GLAZING.

CONSTRUCTION IN PROGRESS



(above, from left) Construction of the cavity wall house well underway; Knauf Earthwool insulation being installed between rafters; the external walls are blockwork with a 150mm cavity, full-filled with Xtratherm CavityTherm rigid PIR insulation.

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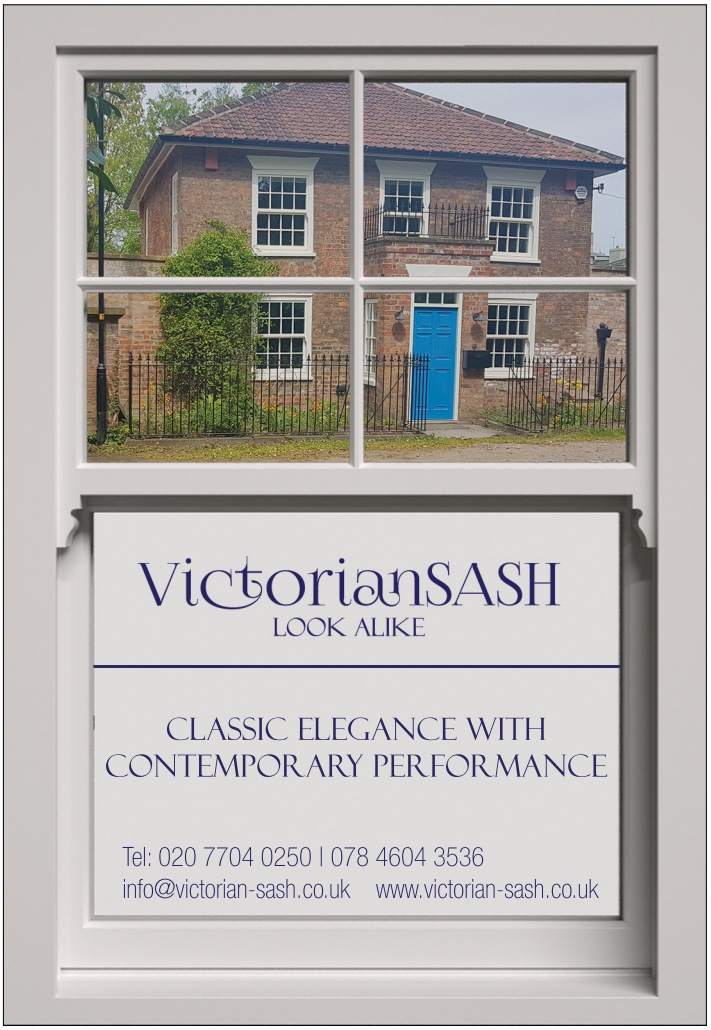

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IN DETAIL

Building type: 389 sqm detached house

Completed: February, 2015

Location: Rathfarnham, Dublin

Passive house certification: N/A (PHPP design-stage figures below based on airtightness of 0.6 ACH, 0.99 achieved)

Space heating demand (PHPP): 18 kWh/m²/yr

Heat load (PHPP): 10 W/m²

Primary energy demand (PHPP): 80 kWh/m²/yr

BER: A2 (33.64 kWh/m²/yr)

Measured energy consumption (heat pump): 1445 kWh per year for space heating, 2213 kWh for hot water. Primary energy consumption of heat pump for space heating: 8.33 kWh/m²/yr (delivered energy: 3.80 kWh/m²/yr)

Energy costs (heat pump only): €202 for space heating, €310 for hot water annually (estimate)

Airtightness at (50 Pascals): 0.99ACH (n50) / 1.40 m³/h/m² (q50)

Heat loss form factor: 2.42

Overheating (PHPP): 0.1% (% of time indoor temp is above 25C)

Ground floor: Kilsaran cement screed (including 30% GGBS) over 2 x layers of Kore EPS 100, over reinforced concrete slab. U-value: 0.148 W/m²K

Walls: External render on 100mm blockwork, on 150mm full-fill Xtratherm CavityTherm rigid PIR insulation fitted in 150mm cavity, on 100mm blockwork – including first course of Quinn Lite blocks – with plaster and gypsum skim internally. U-value: 0.133 W/m²K

Roof (insulated on ceiling): Cold roof structure with 400mm of fibreglass insulation between and above 200mm deep joists Pro clima Intello Plus VCL/airtight membrane below rafters with plasterboard and skim finish internally. U-value: 0.11 W/m²K

Roof (insulated on slope): Marley Clay tiles externally, on battens and counter battens laid on Pro Clima Solitex Plus Breather membrane, on Knauf glass mineral wool insulation between rafters on Pro Clima Intello Plus VCL/airtight membrane below rafters, with Knauf glass mineral wool insulation in service cavity, on plasterboard and skim finish internally. U-value: 0.14W/m2K

Windows: IV 78 + HPI triple glazed aluclad windows, with glazing U-value (Ug) of 0.6 W/m²K and frame U-value (Uw) of 0.9 W/m²K.

Roof windows: Velux triple glazed roof windows, with class four airtightness. (TBC)

Heating system: Nibe F2040 12kW air-to-water heat pump, with indoor VVM 320 module containing preinstalled water heater & buffer tank. Room sealed wood burning stove.

Ventilation: ProAir 600 MVHR unit with effective heat recovery efficiency of 88.8% (PHPP), passive house certified component. SAP Appendix Q: 91% efficiency.

Building type: 211 sqm detached two-storey home

Standard: nZEB / uncertified passive house

Location: Macroom, Co Cork

Completed: October 2011

Build method: Concrete block with external insulation

Heating: Air-to-air heat pump

Budget: €200,000

BER: A2

Energy bills: €350 per year (heating, hot water & ventilation)

> WE ARE CLOSE TO A BYROAD AND SOUNDPROOFING IS REALLY GOOD.

Photos: Jed Niezgoda

LIFE IN AN AIR-HEATED PASSIVE HOUSE

FIVE YEARS ON

Homeowner Brendan Murphy started self-building his Cork passive house way back in 2010, long before the standard was trendy, and even chose to completely forgo a water-based heating system. So what did he learn from the experience — and how has the house been performing since?

by John Cradden

WANT TO KNOW MORE?

The digital version of this magazine includes access to exclusive galleries of architectural drawings.

The digital magazine is available to subscribers on www.passive.ie

Where would we be without early adopters? Five years ago, it's fair to say the passive house standard was not that well known in Ireland, which meant that anyone who consciously chose the standard had to get to grips with stringent new building principles about which little advice was available.

But although Brendan Murphy's house in Macroom, Co Cork is a new build, he initially embraced passive house principles as part of a plan to deep retrofit a 1950s house that had been in his family for generations. It was only after serious structural issues arose with this house that the family decided to knock it down in favour of a new-build.

The way he tells it, the passive house approach naturally came to the fore in his search for the most energy efficient way to build. Although he admits to not always being interested in energy efficiency, a long recovery from a serious illness gave him the opportunity to read up on issues around global warming, which in turn led him to weigh up low energy building methodologies.

"That's pretty much where the passive house thing seemed to come from, because it seemed to be pretty much tried and trusted," he said. Even to someone with no background in construction — Murphy is a vet from a farming family — passive house just seemed the logical thing to do.

Ultimately it was the verifiability of the then little-known standard that made it such a natural choice, particularly in comparison to Ireland's national building energy assessment methodology, Deap.

Murphy approached passive house specialist John Morehead of Wain Morehead Architects to see what could be done with the old house. With the help of localised weather data, Morehead's calculations confirmed that it was possible to reach the passive house standard.

"I didn't feel I was taking a huge risk for two reasons. Firstly, I had complete faith in the PHPP [passive house] software as it was at the time working all over the world, and even if you didn't achieve it fully the deficit could easily be made up with a small heat source like an electric heater."

"Secondly I was self-building in the literal sense so I knew that I could keep a really close watch on building quality, for airtightness especially."

However, when work started on the old house, some structural defects were discovered which would have been difficult to remedy, prompting the difficult decision to knock the house down and do a new build instead.

> THE EVEN TEMPERATURES ALSO MEAN THAT DRYING CLOTHES RAPIDLY IS EASY ALL YEAR ROUND, AIDED BY A DRYING TOWER.

Murphy says: "The original building was rectangular and there was this kind of serious crack where they had put in a sort of a shore drain, and I think it has been leaking over a period of time."

The discovery of another crack running from the ground floor right up to the roof was the final straw. "All our window openings were going to have to be changed as well, and then you had to factor in the fact there was really no foundation in the old house or damp course or anything like that."

Murphy took advantage of the time off work to be the project manager and worked closely with a general builder from Lithuania who, luckily enough, proved to be a stickler for detail.

"I kind of had the theory in my head but he had the wherewithal to put it into practice, and between the two of us we were pretty much on top of everything."

At the time, of course, there wasn't a whole lot of local expertise to tap into. Murphy couldn't afford to hire John Morehead again to work on a full design for the new build, but his previous input on the original house, while brief, would prove to have a major bearing on the new project.

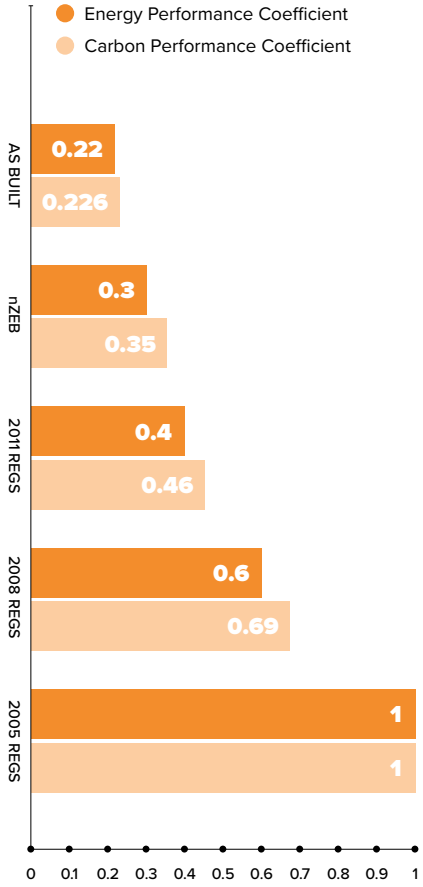
For the roof, Murphy was able to work off the roof specifications of the Denby Dale passive house in West Yorkshire in England, which was built by Green Building Store, while other details and advice was extracted from a book on best practice passive house design.

There wasn't as much to go on in terms of the foundations, however. "You just kind of had to design it yourself and go your own way," he says. Ultimately the team based the foundation on the Swedish Supergrund system, with a tray of polystyrene enclosing the concrete slab.

Maurice Falvey of Nilan Ireland was tasked with the heating and ventilation duties, and Murphy recalls being one of Falvey's earliest customers. The Nilan Compact P heating-and-ventilation unit, now a common appliance in Irish passive house houses, was fitted along with back-up from a 2kW ducting heater (which Murphy says he hasn't needed to use yet).

"We did put in some insulated pipes from outside, so we could have put in an outside heater boiler of some description and retrofit a few radiators if we had to later, but we never did have to, thankfully. We just kind of took a chance that we would get it right and it worked out good enough really," Murphy says. The house has no radiators and no underfloor heating — just the Compact P delivering heat through incoming fresh air.

The vent for the MHVR comes out of the old fireplace, one of a number of items recycled from the original house, along with the roof slates, timber and the rubble wall (for site filler). Only the old PVC windows



> I WAS SELF-BUILDING IN THE LITERAL SENSE, SO I KNEW THAT I COULD KEEP A REALLY CLOSE WATCH ON BUILDING QUALITY.

were thrown out in favour of triple glazed replacements from Amberline.

Aside from a T-shaped section at the back, the new house is built on the same footprint as the old family house and the aim was to recreate its style as far as possible. "The extension on the back is new, but the original house as you look at it is the same house basically, just different window openings, because the windows in the original house were quite a bit smaller."

This additional section had to be built to the rear as the south-facing front of the house is quite close to the road, so this part of the house doesn't benefit as much from solar gain.

If he were starting again, is there anything Murphy would have specified differently, given advances in building technologies and expertise?

Murphy had the option of having a wide 300mm cavity wall, but he decided against it. He says: "They were talking about putting in a 300mm cavity and pumping beaded insulation into that cavity, but my biggest concern with that really was the fact that you were relying on the installer to do this, and you know there could be gaps in your insulation and stuff like that which could be pretty critical to the success of the thing. But they

have sort of improved on that. Although it's inherently more complex, it's pretty doable nowadays I'd say."

He could also have opted at the time for a timber frame structure rather than a block-built one, but given the direct labour/DIY approach, it didn't really suit.

So the burning question is, with the benefit of over five years experience living in this house, what does he think?

Murphy says: "It has matched our expectations and probably exceeded them in a lot of ways. We are close to a byroad and soundproofing is really good. The constant temperature is really something as it's never cold getting up in the middle of the night with small children, or in the morning first thing."

The even temperatures also mean that drying clothes rapidly is easy all year round, aided by a drying tower designed by Morehead, which is basically a winch-up, winch-down rack that dries wet clothes at the top of a vertical space that extends over two storeys.

Murphy also enjoys the brightness from the large windows, which makes the inside of the house feel more in touch with the outdoors.

"You do have to work with the building in some ways, such as closing curtains when the sun goes down ideally, and pulling blinds on really hot summer days, but that's not too often though," he says.

In the first year the house was still drying out, so it wasn't until the second and third year that they felt the full performance.

"It depends on the weather outside too to some degree, you know," Murphy explains. "The house performs really good with dry, cold weather. If it's frosty and sunny outside, even if the temperatures are minus two, minus three, it still performs really well. With mild damp weather it's fine too, but if you get a combination of really cloudy, cold weather that might go on for a week or ten days then that's when the house performs least well."

***Explained:* PHPP**, the Passive House Planning Package, is a software application used for the design and certification of passive buildings.

SELECTED PROJECT DETAILS

Client & main contractor: Brendan Murphy
Project architect: Gerald McCarthy & Co Architects
Architectural & passive house consultancy: Wain Morehead Architects
Civil & structural engineering: Tanner Structural Design
External insulation system: Baumit
External insulation: Rockwool
Insulated foundations: Kingspan
Cellulose insulation: Ecocel
Windows & doors: Amberline
Airtightness products: Siga & Pro Clima
Roof trusses & joists: CRT
Heating & ventilation: Nilan Ireland
Water conserving fittings: Hansgrohe, via Celsis
PV: Solar Frontier

> EVEN WITH NO BACKGROUND IN CONSTRUCTION, PASSIVE HOUSE JUST SEEMED THE LOGICAL THING TO DO.

CONSTRUCTION IN PROGRESS

(clockwise from top left) first floor metal web joist detailing — membrane behind the joists was incorporated into plaster layer for airtightness; the 225mm concrete block walls are insulated externally with 300mm Rockwool insulation; windows are triple glazed, argon-filled Veka Alphaline PVC, and were mounted in brackets in external insulation layer, with frames also overlapped with external insulation; Siga airtightness membrane to first floor ceiling followed underneath by 40mm service cavity for upstairs electrics; ventilation ducting for the Nilan Compact P system.

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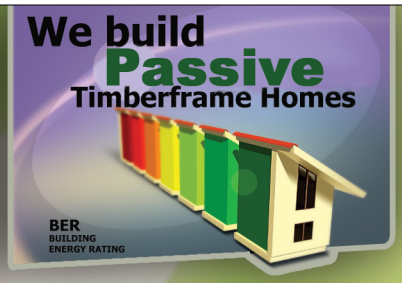

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IN DETAIL

Building type:
211 sqm detached two-storey home

Standard: nZEB / uncertified passive house

Location: Macroom, Co Cork

Completed: October 2011

Build method:
Concrete block with external insulation

Heating: Air-to-air heat pump

Budget: €200,000

BER: A2 (30.36 kWh/m²/yr)

Space heating demand (PHPP):
13 kWh/m²/yr

Heat load (PHPP): 8 W/m²

Airtightness:
0.5 air changes per hour at 50Pa

Energy bills: Approximately €1,100 per year for electricity (there is no other form of heating or energy supply). Brendan Murphy estimates roughly €350 of this is for heating & hot water. Recently installed solar PV should reduce overall electricity bill by c. €300 per year.

Thermal bridging: Windows were mounted in brackets in external insulation layer, with frames also overlapped with external insulation. Supergrund-type passive slab. The trussed roof was modified as per the Denby Dale passive house (Green Building Store) to allow the roof insulation to generously overlap the external wall insulation. All thermal bridges were designed out and default values used for PHPP.

Ground floor: German-type EPS raft foundation enclosing concrete slab. U-value: 0.143 Wm²K

Walls: 225mm concrete block with 300mm Rockwool insulation and 8mm render externally. Internal wet plaster forming airtightness layer. U-value: 0.115 W/m²K

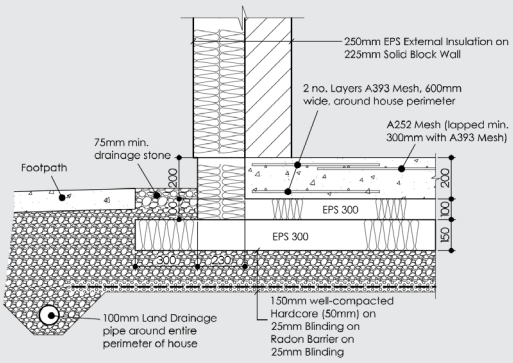
Roof: 300mm cellulose insulation to attic floor with Siga airtightness membrane, 40mm service cavity and 10mm plasterboard below to ceiling. U-value: 0.102 Wm²K. Cold roof construction with taped Pro Clima Solitex membrane on rafters, battens and counter battens and recycled Welsh slate externally.

Windows: Triple glazed, argon-filled Veka Alphaline PVC windows. U-value: 0.6 and 1.0 for glazing and frame respectively.

Heating & ventilation: Nilan Compact P air-to-air heat pump and heat recovery ventilation system with heating element to incoming fresh air (so far unused), also supplying domestic hot water tank. No radiators or underfloor heating.

Electricity: 2 kW Solar Frontier solar photovoltaic array.

Green materials: Recycled welsh roof slate, cellulose attic insulation, timber roof truss and first floor joists.



EXTERNAL WALL FOUNDATION SECTION
Scale 1:20




The PH+ guide to:

EXTERNAL INSULATION

In the first in a new series of technical articles on some of the key technologies in sustainable building, John Hearne makes the case for wrapping buildings in an external insulation layer, and describes some of the main issues to watch out for.

The phrase you often hear when people talk about external insulation is 'like a tea-cosy'. It's an image that captures the simplicity of the concept perfectly. You wrap the building in one continuous layer of insulation, preserving its thermal mass and eliminating thermal bridges in one fell swoop. Because the insulation is located outside the structure, its dew point lies close to the exterior of the building, which means the risk of condensation within is eliminated. The wide variety of materials and finishes available gives designers and builders ample choice, both from an engineering and an aesthetic point of view. It's buildable, robust and creates structures that are warm, dry and healthy.

It's not surprising therefore that so many of the passive and low energy projects we have featured in Passive House Plus over the years have included external insulation as a core element. Nor have these projects been restricted to new builds. External wall insulation, or EWI, is equally popular in retrofits, where – with best practise design and build techniques – it delivers very high levels of thermal comfort simply and efficiently.

It's also worth pointing out that when installing EWI, the cost of increasing the spec – going say from 100mm to 200mm – is nearly always minimal. The prime costs of the technology are the fixed costs: scaffolding, the fixings, the plastering. These elements don't change much if you opt for a thicker profile; you're only paying for the additional insulation materials.

This is an important point. If you're going to externally insulate a building, be as ambitious as you can. It's not something that you will return to again. In both Ireland and the UK, grant level target U-values stand at 0.27 W/m^{2}K. This is an exceptionally poor standard to aim for – and will look a lot poorer with each passing year. When you consider the low marginal costs involved in securing U-values of 0.21 W/m^{2}K or even 0.15 W/m^{2}K, it makes eminent good sense to do so.

In retrofit situations, external insulation brings the added benefit of giving the building a de-facto facelift. In any row of houses, it's always easy to tell which one has had EWI installed. From a resale point of view, you're not only boosting the energy profile of the house, you're also improving the aesthetic.

Then there's the space argument. Architect Jay Stuart is responsible for this simple exercise: Suppose you're retrofitting a 100 sqm three bed semi (5m wide by 10m deep on 2 floors) and you want to achieve a wall U-value of 0.21 W/m^{2}K. Internally insulating the house would require about 85mm of rigid insulation finished with 12mm plasterboard and a 3mm skim coat. In total, that's 100mm that you're adding to the inside of the external walls of the house. The total length of the insulated wall is 40m [(5m+5m+10m)x2], and this in turn gives you 4 sqm of lost floor area (40m x 0.1m= 4m) which is worth about €2,695/m^2, or €10,780 worth of real estate in the Dublin area at today's prices.

This is all without considering the disruption that retrofitting internal insulation involves – removing and refitting skirting boards, rads, sockets – and the associated co-ordination of trades that comes with that. Remember too that large sections of the house will be uninhabitable while the work is underway.

One of the big advantages of EWI retrofits is that, depending on what other measures are being done, the occupants may not have to move out, which can have a significant impact on project cost.

Though external insulation can sometimes feel like the new kid on the block, these systems were originally developed on the continent following the second world war, and saw their popularity increase substantially following the oil crises of the seventies. They have been in use in the US since the mid-sixties.

There are five main types of EWI on the market in the UK and Ireland:

1 EPS

Expanded polystyrene, or EPS, is the most popular and least expensive insulation material used in EWI systems available on the market at the moment. The white EPS we're all familiar with has been the mainstay of external insulation for years and has a typical thermal conductivity of 0.037 to 0.040 W/mK. More recently it's been superseded by grey EPS, which is graphite enhanced and has a superior conductivity value of circa 0.031 W/mK. Effectively what this means is you get the same performance from a thinner profile.

EPS is regarded as easy to work with. It's lightweight, cuts easily yet is quite robust. It's also well suited to our climate in that it can get wet during installation without suffering any loss of thermal value. Because it's so common, you can get it in virtually any thickness you want.

2 Mineral wool

Another familiar material, mineral wool sits at the lower cost end of the spectrum and has a thermal conductivity in the region of 0.036 W/mK. It's got the best fire proof credentials – mineral wool just won't burn. This is one reason why it's often specified in social housing and commercial multi-storey buildings, and why it's used as a firebreak in other projects. It's regarded as a little harder to work with; it's more difficult to cut, and has that 'itchy' factor. It also needs to be kept dry during the install. Having said that, if it does get wet, its performance will return once it's allowed to dry out fully. Mineral wool is fully breathable – meaning that any moisture/water vapour in the structure can pass to the exterior surface unobstructed. That said, as with all insulations, breathability is only maintained if the finish is itself breathable. Of this, more later.

3 Phenolic

Among the most expensive but also the best performing materials on the market, it has a thermal conductivity of 0.021 W/mK. Because it's such a high performance material, it's sometimes the only viable option for, say, narrow passages between houses; a thinner profile can deliver the required U-value without rendering the passage unusable.

In the same vein, one of the many building elements you have to consider on retrofits is the roof overhang. Again, a thinner insulation profile may obviate the need to extend that overhang.

Phenolic insulation is fireproof and is generally available in 10mm increments from 20mm to 100mm, though it is possible to double up in certain situations – assuming trained, certified fitters. Practitioners say that it does tend to require thicker base coats and additional fixings compared to other insulations – this contributes to the higher costs involved. It must be kept dry during installation.

4 XPS

Manufactured since the 1940s, the process of extruding foamed polystyrene results in a material with uniformly small, closed cells, which gives the foam superior rigidity, making it highly resistant to compression, and a thermal conductivity of circa 0.34 W/mK. XPS has natural resistance to rain, snow, frost and water vapour, and is an exceptionally stable material, retaining its initial insulation performance and physical integrity in exposed conditions over long durations. Properly installed, XPS boards have a service life comparable with that of the building or structure. XPS is commonly used for the plinth detail, below DPC in many external insulation systems, because of its unique benefits – but it can be used for a whole wall system.

5 Wood fibre

Wood fibre EWI has the best green credentials. With a thermal conductivity in the region of 0.039 W/mK however, you do need more of it to deliver equivalent thermal performance. It's also a little more expensive than mineral wool, is fully breathable (again when used in conjunction with the right finishes and adhesives) and is more commonly found on timber frame structures.

The fibrous structure of the wood allows it to accumulate and store warmth during the day, then release it at night when the temperature drops, delaying the occurrence of condensation on the surface and thereby making the finished render less susceptible to mould and algae growth.

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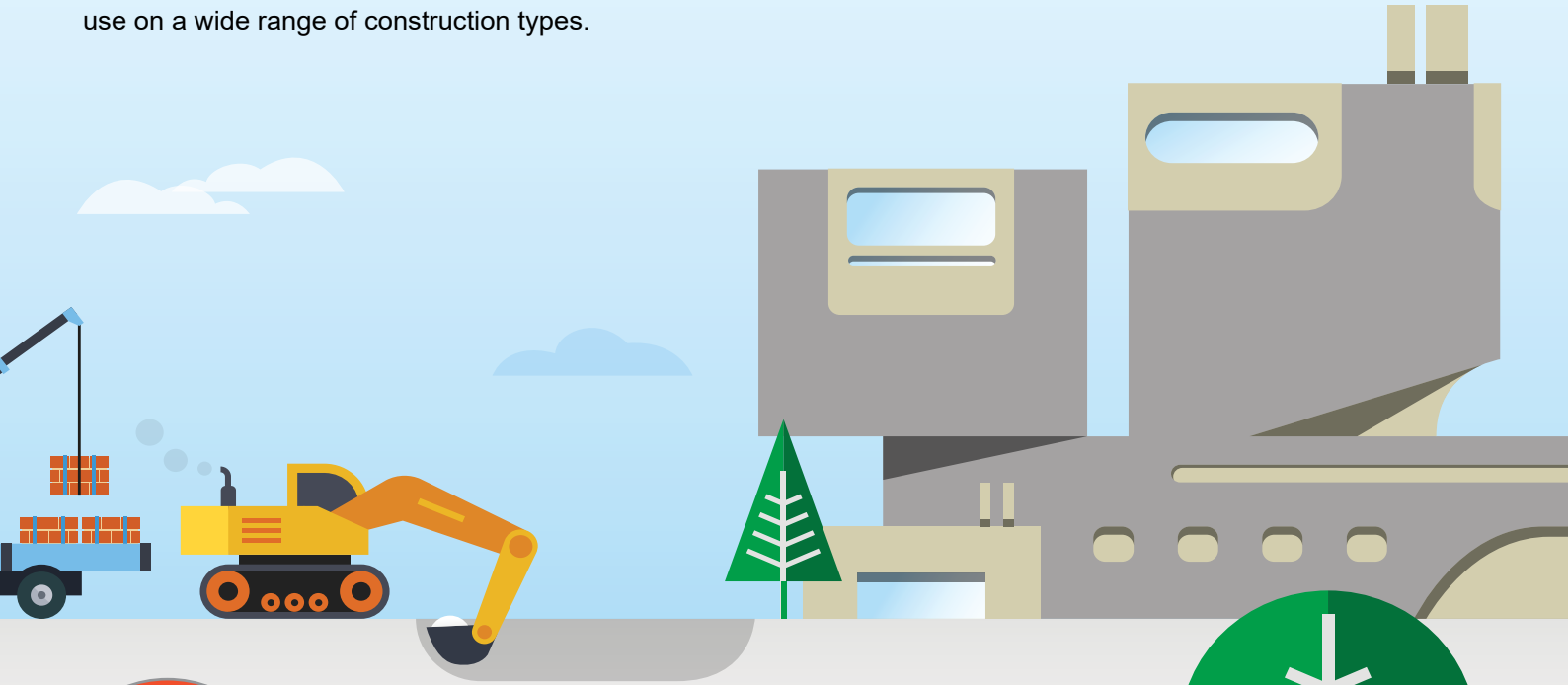

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Getting the right people

Oversight and quality control is absolutely vital when installing EWI. You can have the best system in the world but unless it's installed by tradespeople who know what they're doing, it will fail, and product failure isn't just about under-performing insulation. Poor workmanship, poor detailing, poor planning and inadequate dialogue between the trades and professionals involved can end up damaging the structure, and seriously compromising indoor air quality.

It's vital that the installers are both trained and recommended by the manufacturer. In Ireland the NSAI runs a register of EWI installers, which involves auditing installers' work. Meanwhile in the UK the Insulated Cladding and Renders Association (INCA) includes contractors among its members, who are required to have health and safety certifications and UKAS certified managements systems such as ISO 9001 or PAS 2030, and SWIGA, the Solid Wall Insurance Guarantee Agency, operates a robust quality and technical framework backed up by an independent surveillance scheme monitoring installations carried out by its members.

This is important: On grant funded Irish projects, double check the day before the project begins that the contractor is still registered with the SEAI, and contact the agency to ensure that the contractor's insurance cert and tax clearance are still valid.

Detailing critical junctions

While the concept of EWI itself is simple, the process of installing it is not. That's particularly true in retrofit situations, where a variety of issues need to be taken into account.

On retrofits, the process of fitting EWI moves windows and doorframes outside the insulation zone. Best practice would advise moving them forward into the new insulation zone, but because this is an expensive option, it's rarely done unless window replacements are also planned. The reveals now comprise a substantial cold bridge, so it's vital that the design team creates a detail to deal with that.

Particular care must be taken with sill overhangs, while the sides of the sill are sometimes insufficiently robust to prevent moisture ingress. For that reason, close co-ordination is required between the window supplier, the contractor, the architect who details the junction and the EWI installer. In Germany, it's become increasingly common to fit a flashing to the underside of the sill to allow any moisture to drain away.

Another key vulnerability in retrofits lies at the point where the wall insulation meets the roof insulation at the eaves. In traditional roof design, the rafter is fitted over the wallplate using a birdsmouth joint. Structurally, this makes perfect sense, but from an insulation point of view this detail squeezes the available space in which to fit insulation down to almost nothing. This is an issue with all retrofits, no matter what type of insulation you're using. Remediating the problem is difficult, physically demanding work. The eave soffit has to be removed and a piece of high performance insulation – cut to the exact size of the space – has to be fitted.

It should also be said that unless an appropriate roof detail is specified at design stage, this issue can and does frequently arise with new builds as well.

If the thermal bridge remains, it will represent a weak spot in the thermal envelope which could lead to condensation and mould growth, with its attendant impact on indoor air quality. For the record, it's also important to cite the vital importance of adequate ventilation in your project – whether new build or retrofit.

Other critical junctions that the design team must tackle include around cable boxes, gutters and below the DPC. System providers will all have standard details which should be reviewed carefully during the planning stages, and any amendments made in time to brief the trades involved.

Fixings vs adhesives

All 22 EWI systems currently approved by the NSAI use both adhesives and mechanical fixings. Adhesives are used to seal and bond the board to the substrate, to prevent it from bowing during temperature changes, and to ensure there will be no air circulating between the insulation and the wall against which it is bonded. If air does get in there, it can prevent the insulation from achieving its specified U-value.

All systems also require a minimum number of mechanical fixings. Modern fixings are thermally broken and do not in any way compromise the effectiveness of the system. It's advised that wind loadings are calculated on exposed buildings in order to determine whether additional fixings are needed. Additional fixings may also be required if the surface of the wall is brittle, dusty

Detail photos from an external insulation project in Wicklow by passive house architects MosArt, showing (clockwise from top left) old concrete sills cut back for installation of new external insulation; windows mounted proud of the original walls for placement in the new external insulation layer, with Compacfoam thermal break at window sill and heavy duty EPS insulation below the damp proof course; installation of the 240mm graphite EPS external insulation system; the EPS cut to fit into the eaves; installation of the Parex render system to the external insulation; the finished house after rendering.



(left to right) External insulation has a longer history of use in Ireland than is commonly known. The Aerobord offices in Askeaton, Co Limerick were externally insulated with EPS in 1966; in 2010 Aerobord tested samples of the original insulation, which indicated that its thermal conductivity was the same as when it was first fitted; the Green Building in Temple Bar was externally insulated with 100mm of Rockwool and an Eglinton render in 1994, and it has been performing well ever since.

or layered with flaking paint, which could affect adhesion strength.

Finishes

There are a wide range of options here, but two standard ones – ready-to-use wet renders and what are known as mineral renders. The former come to site in a bucket, pre-tinted to the required colour – so no painting necessary. These ready-to-use finishes also come in different grain sizes, from 0.5mm to 3mm depending on the texture required. Some incorporate an anti-microbial agent to inhibit mould and algae growth. These biocides are very helpful in preventing the discolouration that can blight the appearance of renders over time.

Staying with the ready-to-use option, you can choose between basic acrylics and silicon based renders.

An acrylic render contains an acrylic resin to make it water resistant and less prone to cracking. It's generally cheaper than the other options because it only requires one coat. It's flexible, long lasting and holds its colour well. It is not breathable however, so it doesn't make much sense to use it with a breathable EWI like wood fibre or Rockwool.

Silicon based render has become a lot more popular in recent years, to the point where it dominates the market. Like acrylic, it's flexible and won't crack. You can get self-cleaning silicon renders for a low maintenance finish. Experts favour these renders for projects in close proximity to motorways, where particulate matter can cling to walls. Its resistance to water also makes it a great option for coastal regions, where salt can attack the face of the render.

The key characteristic of silicone renders is their breathability, which makes them a natural fit with breathable EWI.

Mineral renders come in a bag – you just add water and mix. They're sand and cement based and are breathable. They can be coloured, they can have different textures and can also come as either thick coat monocouche types or as thin coat render. Naturally enough, they are more labour intensive, and because you have to mix onsite, getting consistency in colour isn't always easy. Mineral renders dry more quickly than their ready-to-use equivalents – so in uncertain weather conditions, they do offer something of an advantage.

Brick slip cladding is another option. Brick slips are thin slices of masonry which perfectly mimic the appearance of traditional brickwork. Skilled plasterers can also replicate this type of finish with renders.

Getting the finish right is as important as getting the insulation type right. Take the time to assess your building, taking into account where it is and what it will be exposed to before choosing the most appropriate product.

Weather during installation

Mild, dry, non-humid weather provides the best conditions in which to install EWI.

From the installation of the board, through to the application of the range of specialist tapes and seals at junctions and windows, right through to the plastering itself – it's vital that moisture not be allowed in or behind the EWI system, because it can lead to potential failure. Wood fibre and phenolic systems are particularly vulnerable and cannot be allowed to get wet during installation.

Dry conditions are also best for applying render finishes. For one thing, it is difficult to plaster onto wet surfaces. For another, heavy rains can wash off primers and other protective coats, leading to a situation where they need reapplication, with a knock-on impact on cost.

Manufacturers frequently recommend fixing tarpaulin or an equivalent protective layer to the outside of the scaffolding throughout the installation and rendering phase. That's going to be particularly important in exposed areas, coastal areas and in places where wind-driven rain is a particular risk.

As an alternative to a rendered finish, it's possible to batten and clad, giving you a drainage cavity that allows any moisture that gets through the external layer to drain away. This is a more forgiving spec, because if moisture does get in during construction and indeed over the life of the building, it can be dealt with. This kind of finish is sometimes recommended in more exposed locations. That said, a high-spec silicone render can be equally effective in harsh environments.

Care should also be taken to avoid rendering during very hot weather or during very cold weather. Generally speaking, you don't want temperatures below 5C or above 25C. Follow the manufacturer's instructions to the letter.

Durability

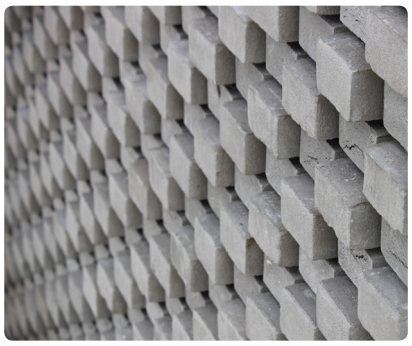
The combination of professionally applied EWI and one of the modern renders will give you a finish that will not crack as a result of movement. There's a high degree of flexibility built into the system – from the boards themselves through the fixings and the finish. A reinforced mesh fitted over the insulation and under the render also adds to the robustness of the surface, making it highly resistant to impact. Well finished EWI can withstand the usual punishments a building must take – low level impacts/balls being played against it and so on. A long list of schools have been retrofitted with EWI.

Thermal bypass

While best practise requires an airtight internal envelope in order to prevent warm air escaping and water vapour from penetrating the structure, you also need a wind-tight external envelope to make sure that the insulation works as intended. Correctly fitted, with sealed junctions and joints, EWI provides an excellent wind tightness layer that will be critical in preserving the U-values of the materials you will use in your project. Some insulated boards are also tongued and grooved, which lends further assistance in this area.

That said, it's important if externally insulating a cavity wall that the cavity itself also be pumped in order to avoid allowing any airflow between the heated space and the insulated space. The smallest gaps in the EWI could end up creating airflow in an uninsulated cavity, and that can have a significant influence on thermal resistance, which in turn will lead to underperforming insulation. To put it another way, wind tightness doesn't so much improve U-values, rather, it allows you to achieve the specified U-values.





A wide variety of finishes are available for external insulation systems, such as (left to right) silicon render, which is regarded as flexible, 'self cleaning' and low maintenance; mineral render, which is sand and cement based and mixed on site; and brick slip cladding, essentially thin slices of masonry designed to accurately mimic the appearance of brickwork, and seen here in a particularly unusual architectural form.

External insulation and airtightness

It's a question passive building practitioners are frequently asked. What role does EWI play in achieving airtightness in the structure? The short answer is very little. Airtightness relies on a continuous air impervious layer, with minimal junctions or gaps. EWI, by its nature, will have numerous penetrations at windows, doors, service junctions and so on. In short, you cannot rely on EWI to double as your airtightness layer.

There's a secondary point to make here that's no less important. In timber frame structures, the airtightness layer also acts as a vapour control layer. Therefore, even if we were to assume that it was theoretically possible to deliver airtightness using external insulation, the absence of a vapour control layer on the warm side of the structure could cause serious problems down the line. Moisture vapour moving through the structure could condense before it reaches the outside – and even if it doesn't, you are open to the risk of prolonged periods of high humidity, generating both structural risks and poor indoor air quality.

Consumer protection

Typically in Ireland and the UK, EWI manufacturers will offer some form of material warranty. The lengths of these warranties vary - check with the system provider in question for details. Also, under grant-aided SEAI schemes, installers must give a two year workmanship warranty. Some systems also offer an insurance-backed warranty. Again, details can vary, so ask for policy details.

The National Insulation Association of Ireland is currently scoping out a guarantee scheme which would offer cover of up to €20,000 out to 25 years, and would include defective materials, design and workmanship. Passive House Plus will be keeping an eye on this and will report on any developments.

On the wider subject of consumer protection, there are many voices within the building industry who would like to see a greater role for latent defects insurance or LDI. LDI offers 'no fault' protection to homeowners against serious structural defects. You don't have to go to court and pin the blame on anyone to get the problem remedied. LDI is compulsory in France, but is less common in the UK and almost unheard of in Ireland.

Insurance backed guarantees are now well established in the UK. SWIGA, the Solid Wall Insurance Guarantee Agency, was set up to give householders an independent, uniform and dependable guarantee covering professionally installed insulation systems.

The SWIGA quality framework ensures that all stages of the work, from survey to design and installation are carried out by competent companies using skilled people, and that it is guaranteed to meet high standards.

Material sustainability

Life cycle analysis will help point the way towards the most environmentally sustainable construction methods and materials. For the moment however, this discipline is still in its infancy. In its absence, it is difficult to make definitive statements about the credentials of the different materials. While it's not controversial to say that wood fibre is the most sustainable of the EWI products on the market at the moment, without knowing specifics about sourcing, about the supply chains of the different products, about the context of the building, comparisons are tricky.

For example: Judicious use of steel may remove the need for a much larger proportion of concrete in the building, and yet pound for pound, steel is the more polluting product. Context is everything.

Environmental Product Declarations or EPDs are standardised indexes of the environmental credentials of a particular product or system. These are becoming more common, and they do form an important element of life cycle analysis. It's worthwhile asking for an EPD when choosing a system, but we're still quite a way from the point where we can make robust comparisons in relation to particular buildings.

It is however worth making the general point that a robust fabric-first approach – which includes EWI – will continue saving energy for decades after high-tech energy saving solutions have reached their end of life.

WITH THANKS TO

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Next issue...

The PH+ guide to:

Thermal breaks

The next issue of Passive House Plus will include our guide to thermal breaks, explaining the reasons why thermal bridging is such a priority in low energy building, and how to detail and spec out a building to avoid the problems that cold bridging brings.

The state of deep retrofit

Regardless of how good new build standards are, the UK and Ireland need to drastically cut carbon emissions from existing buildings if we are serious about tackling climate change. So why has there been such little progress on the deep retrofit of our building stock — and what can be done about it?

by John Cradden

We've been talking about deep retrofit for years, but it's fair to say the central question today is not why we should do it — but how.

It's hard to argue against the need to stimulate the deep retrofit market. The challenge of reducing the approximately 40% of CO_2 emissions that emanate from the built environment means we must make our existing buildings drastically more energy efficient. After all, only about 1% of this stock is made up of new buildings constructed to a reasonably good energy efficiency standard. But in both Ireland and the UK, we're still getting stuck on the how-to.

Deep retrofit in Ireland

So far in Ireland, there has been no significant national effort to specifically address the deep retrofit challenge, but that looks set to change with a new €5 million government pilot scheme. Launched in April at the Sustainable Energy Authority of Ireland's (SEAI) Energy Show in Dublin, the scheme aims to provide financial support for folks who want to upgrade their existing home to an A building energy rating (BER).

The funding will, for now, only be made available to those — such as neighbours or friends who live locally — who can organise as a group to apply collectively for funding for up to half the cost of their respective upgrades, building on the success of SEAI's Better Energy Communities scheme, which this year provided €26m worth of subsidies for 44 community projects, including housing along with public, community and commercial buildings.

Speaking at the launch event, climate action

and environment minister Denis Naughten said: "People live in a wide variety of homes across a broad swath of locations and they live in very different circumstances, be they homeowners or renters. We need to develop a range of solutions that will work for everyone. Achieving the transition to a low carbon energy system in our existing housing stock is not just an Irish challenge, it is a global one. But we need to develop, from the bottom up, a range of solutions to create the evidence base for what really works in Ireland."

SEAI chief executive Jim Gannon says the aim of the pilot scheme is not just to find the answers or solutions — but to ask the right questions in the first place. "It's to really look at it from first principles as we look to precedent in other jurisdictions, because it's a complex problem," he says.

"And I think that a lot of other jurisdictions have tried option A, option C or option E, but what we are trying to do is to start with a blank sheet of paper, start with the housing archetypes, the technical infrastructure we need to bring up to a certain standard, and then start looking at the different pillars of activities that need to catalyse that sort of retrofit."

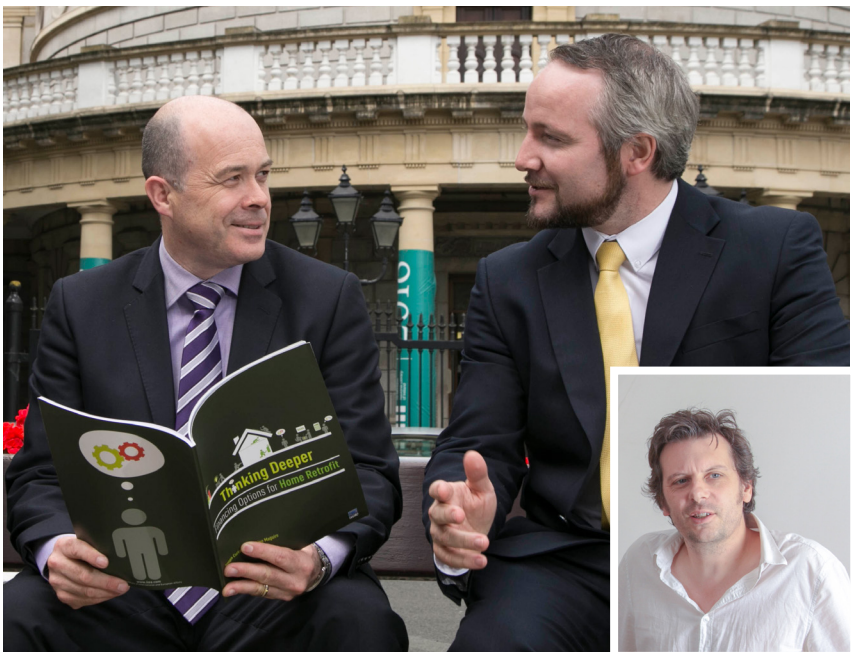
While SEAI is firmly in the driver's seat with regard to national retrofit initiatives, Gannon is keen to stress the importance of input from as many stakeholders as possible. The first of these opportunities will come with the inaugural National Deep Retrofit Conference on 21 June at the Aviva Stadium in Dublin. "I don't think the solution rests in one entity or the state in isolation keeping its shoulder around its copy book. I think that it must be a range of voices, a range of perspectives that can solve it."

Some of these voices, he hopes, will come from those involved in existing deep retrofit projects and, according to Gannon, some homeowners and architects have already come forward. "And as far as we are concerned that's fantastic. That's great value. So whether someone is within or outside the pilot they can all contribute valuable perspective, data, and experiences and that goes not just for projects ongoing within Ireland, but also internationally."

Starting from scratch to find the right solutions means the industry will have to be patient, he says, but he intends to continue having a retrofit conference every year until there is some clarity on the issue. "We will share all of the evidence with everyone, but I think that the first few questions we will be asking will be more technical."

One thing that is clear is that rather than a plan of individual measures done in isolation from each other, a deep retrofit approach must entail looking at the whole home as a system, and figure out how different recommendations might interact with each other, with solutions designed accordingly.

One local organisation that will be keen to feed into this process is Tipperary Energy Agency, which has been running a deep retrofit scheme called SuperHomes. It aims



(opposite page) A 6-unit terraced housing scheme in Farmsum, Groningen upgraded to a net zero energy bill standard as part of the Dutch Energiesprong approach. | (above) Climate action and environment minister Denis Naughten discussing deep retrofit with SEAI CEO Jim Gannon. | (inset) AECB CEO Andy Simmonds argues that the UK's Green Deal and ECO schemes have provided evidence on what not to do.

to bring the BER of participating dwellings up to at least an A3 — airtightness measures, advanced ventilation and renewable heating are all mandatory, but the exact suite of measures (potentially including various types of insulation and window upgrades) varies for each property.

However, chief executive Paul Kenny says that getting the general formula right took a lot of work — and there are still very few people with the technical knowledge required to do deep retrofits properly.

"This is very understandable – we as retrofit professionals are only coming to the clear conclusions over the last 18 months of what is the best way to achieve a low cost comfortable home," he said. "The reality of the shortcomings of ventilation systems, how to retrofit robust airtightness and integrate renewable heating systems is only known well by a few experts — and this needs to be known by every contractor, engineer and architect across the state."

Deep retrofit in the UK

In the UK, retrofit is in something of a limbo. Funding for the failed Green Deal, essentially a retrofit finance scheme, was stopped in 2015 while the ECO scheme, which requires energy suppliers to install energy saving measures in homes and whose costs are passed onto energy bills, has been cut back but will continue in a much reduced form until September 2018.

The two schemes, which were launched in 2013, were intended to combine together to improve one million homes by 2015, but a report by the National Audit Office found that the Green Deal was not delivering value for money, and that the target was met almost solely by ECO. In fact, just 14,000 homes took out Green Deal loans, which represents just one per cent of the one million homes that got improvements under the two schemes. It's also no coincidence there was a dramatic decline in insulation measures after 2012.

Furthermore, when ECO was first launched, suppliers were required to meet their targets by improving harder to treat solid-walled homes. As previous supplier-obligation schemes had absorbed most of the demand for easier and cheaper measures like attic insulation, the government wanted to encourage suppliers to develop more efficient ways of improving these properties. However, this requirement was relaxed in 2014 after government ministers expressed concern about inflated energy bills, thereby undermining any progress towards better deep retrofit design.

So it looks like the UK may, too, have to start again with a blank sheet of paper in order to stimulate deep retrofit, although Andy Simmonds, chief executive of the Association for Environment Conscious Building (AECB), notes that "the Green Deal and ECO threw up lots of design, spec and installation problems, providing lots of potential evidence for what not to do".

For the industry, it's clear that things are not helped, on both sides of the Irish sea, by ongoing confusion and lack of clarity on the EU's nZEB (nearly zero energy building) targets, says architect, lecturer and Passive House Plus columnist Simon McGuinness. The EU's recast Energy Performance of Buildings Directive requires member states ▶

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to "stimulate the transformation of buildings that are refurbished into nearly zero energy buildings", without setting specific targets.

"Energy performance targets on both sides of the Irish sea have come and gone with the regularity of ministerial appointments, with the result that there is little buy-in, and the industry is left in a state of some dysfunction," McGuinness says.

"Faced with this confusion, progressive developers on both sides of the Irish Sea have grasped for the relative clarity of the passive house standard as something of a life raft in an otherwise unsettled sea of regulatory debris. They have found it easy to understand, even logical, and find within it sufficient latitude for innovation and incremental improvement."

But Russell Smyth of Parity Projects, a London-based agency specialising in retrofits, says that while you can't argue with the passive house standard and the passion it inspires in its advocates, it's too ambitious a standard for the majority of deep retrofit cases.

"I've heard people say that we should ignore the houses owned by people who don't want to upgrade to passive house standard and focus on those that do, but try saying that to the 44,000 people who died in 2016 (in the UK) because of excess winter deaths, because their houses were too cold. We've got to find a compromise."

Meanwhile Fintan Smyth, building physics manager at Saint-Gobain and a certified passive house designer, says that while he believes in the approach for new builds, Enerphit (the passive house standard for retrofit) should not be the short-to-medium target for en masse retrofit of single family dwellings on a normal budget. (The cost implications of meeting deep retrofit standards such as Enerphit may be much more favourable on scalable multi-unit schemes, such as terraced housing or apartment buildings.) Smyth reckons that even without an extension or remodelling, you would probably have to spend €60-70,000 on a passive retrofit for a typical semi-D because of the likelihood of having to take up the floorboards, excavate ground slabs, put in ventilation ducting, re-plaster, re-do the staircase and install a new kitchen.

"The knock-on implications of trying to improve the energy efficiency by that extra bit [to reach Enerhpit] are massive. Therefore economically, and from my perspective, environmentally, the damage that you are doing having to recreate all of those materials, and put so much material in the bin, can often be counterproductive".

He believes an integrated deep retrofit approach like that of the SuperHomes scheme is a better way to go. "Done right, this can create a springboard for step-by-step passive house retrofit. This means do each job to the proper standard, and in a manner that accommodates the successive measures."

However, he says it's crucial that solutions are properly considered in terms of economics, environmental impact and their effect on occupant health and well-being. "This means careful detailing for thermal bridging and airtightness combined with a suitable ventilation strategy."

"This is not to say that passive house retrofit is not beneficial on a case by case basis. Where a home is being completely renovated and/or extended, a passive house solution is very worth considering."

Tim Martel, a Gloucestershire-based retrofit co-ordinator and passive house designer, agrees that deep retrofit could be done in incremental steps or 'packages' of work. The 'step-by-step' approach to deep retrofit was the basis of the recent EU-backed Europhit scheme.

Martel says: "An overall plan is written for the house in the same way as if it was completed in one stage. This is then divided into three to five steps. The interest of a particular owner might only be 15 to 20 years, so they make a small investment which is cost-effective over that timescale which contributes to the overall plan. There may be large co-benefits for the owner and when included, these help to swing the economics in favour of a deeper retrofit solution."

Martel also speaks to the benefits of retrofitting to the local and national economy, and says the payback to the exchequer should be passed back to home owners to further stimulate the process.

"This alone, we already know, is not enough to make it happen, we also need regulation and information campaigns on a national scale, maybe in a similar way to what has worked quite well in Germany. Fundamentally, though, additional funding could be provided for projects which is cost-neutral, paid for through Vat, income tax and, if we are bringing people into employment who weren't before, a reduction in support costs."

Back in Ireland, SEAI will naturally be adding notes to its own deep retrofit drawing board on lessons learned from successful schemes in other countries, such as the much-touted Energiesprong scheme in the Netherlands.

Chief executive Jim Gannon was reluctant to name-check any specific schemes, but said there were "many very, very good approaches out there", whether they related to the technical aspects, the design philosophies or the consumer activation side.

"I'm just not sure if we pick one horse, will it serve all of the range of housing types and the range of home owners that we have," he said. "And that's what I think we need to determine here, because we know that technologies behave differently in the Irish climate — both economic and natural — than on the continent. And we have a particular sort of cultural perspective here that also makes things slightly more challenging."

While the primary target is to upgrade the housing stock to the point where it helps Ireland meet its 2050 carbon reduction goal, Gannon is also anxious not to set technology or price targets.

"So to my mind if I set technology targets now or a price target now and say, well, we must get the solution to be €27,500, that pre-determines the answer to some of these questions." he said. "And I think it would skew the market, frankly. I think it would send inappropriate signals to the supply chain. I think it would send inappropriate signals to those approaching homeowners and trying to activate them."

But he stresses that it will be a very open process. "And I think everybody, even those who are in their own design doctrine, who are within their own technology box — because they export or supply — they need to open their minds also."

"There's a huge amount of retrofitting to take place out there, and I'm not sure that only one doctrine — or only one technology solution or only one finance option — is going to cut it."

(above) Tipperary Energy Agency's nationwide SuperHomes scheme takes a novel approach to deep retrofit, with typical measures such as installing air-to-water heat pumps running constantly at low temperatures on radiators, combined with whole house mechanical ventilation systems, along with airtightness work.

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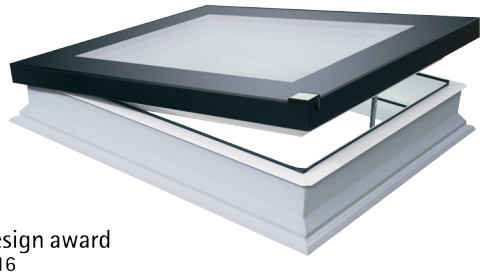

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Feel the calm that comes from silence, even on a rainy day, thanks to the Type F flat roof window. Its superb sound proofing** and thermal insulation make it ideal for Passivhaus designs while the sleek sash construction increases the glazing area and optimises use of natural light. With exceptional overall functionality, the DEF sets the standard for flat roof windows.

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The Enterprise Centre

University of East Anglia - Greenest Building in UK

The £11.6m University of East Anglia Enterprise Centre has been described across various media sources as being the greenest building in the UK to date. Built to Passivhaus principles using natural and bio-renewable materials sourced through local supply chains, it was the region's first to achieve a BREEAM 'Outstanding' rating. The 3400 sqm building exemplifies the use of low embodied carbon materials, so the windows were required to demonstrate a demanding standard of thermal insulation. Architects Architype, twice winner of the 'Sustainable Practice of the Year' and specialists in the design of education buildings, found that the triple-glazed FAKRO DEF DU6 flat roof window offered unparalleled performance with a U-value of 0.88W/m^{2}K. Its use of a triple-seal TPE system proved superior to any other product of its type and was chosen because its design limits the formation of air leakage paths and thermal bridges. Seven 120 x 220cm windows were installed.

In addition to the use of renewable technologies such as MHVR and photovoltaic panels, the walls are timber frame and have thatched cassette panels which were made off-site. Ventilation and air handling were at the heart of the design to ensure the highest standards of performance, and a range of scenarios were simulated in 'PHPP' (Passivhaus Planning Package). This identified the most robust solution over an 87 year period, taking particular account of glazing ratios and using sensitivity analysis for both warming and cooling. The practice also carried out a design study which assessed the requirements for adaptable shading and solar gain.

The building exceeds a local planning requirement for 10% of its energy to be from PV panels, and overall the design far exceeds 'best practice' with embodied carbon between 1/5 and 1/4 of many new university buildings. To ensure that it met user needs at each design stage, a DQI (Design Quality Indicator) process was used to record consultations in conjunction with BSRIA's 'Soft Landings' framework.

The Enterprise Centre has won a host of accolades including:

- The 2016 BREEAM Award for **'Best Education Building'**
- The AJ Reader's Choice Award for **'Building of the Year'**
- The 2016 BCO National Awards for **'Best of the Best'** and **'Best Corporate Workplace'**
- The 2016 Constructing Excellence National Awards for **'Innovation Project of the Year'**
- The 2016 Structural Timber Awards for **'Best Use of Timber'** and **'Best Low Energy Project'**
- The 2016 Construction News Awards for **'Sustainable Project of the Year'**
- The 2016 Guardian Sustainable Business Awards for **Winner, 'Built Environment' Category**
- The 2016 LABC East Anglia Awards for **'Best Education Building'**

Designed to provide a 100-year design life, the Centre will perpetuate the Passivhaus design principle by providing a base for new, sustainable businesses set up by graduates and those involved in the Norwich Research Park. Professor John French, CEO of the Adapt Low Carbon Group which commissioned the building and shepherded its construction concluded, "we wanted to create the ultimate sustainable building. Our brief was to make The Enterprise Centre low carbon, both in operation and during construction, and to stimulate the local economy."

Marketplace

Keep up with the latest developments from some of the leading companies in sustainable building, including new product innovations, project updates, events and more.

Angela Merkel opens €50m Viessmann innovation centre

German Chancellor Angela Merkel opened the Viessmann Group's new technological research and development centre in Allendorf, Germany on 12 April.

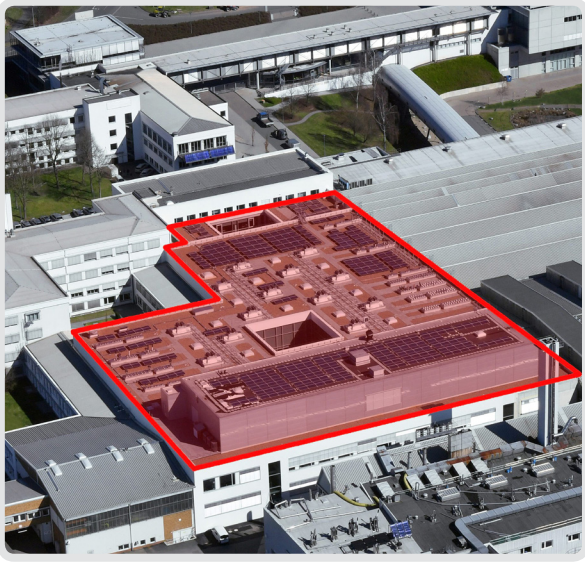
The €50 million investment by Viessmann, one of the leading international manufacturers of heating, industrial and refrigeration systems, sets a milestone in interdisciplinary development and innovation, the company said.

The Viessmann Innovation Centre will employ 100 people and up to a further 60 additional colleagues in various teams. Here they will be tasked with developing prototypes and turning them into marketable products, as well as carrying out testing. The innovation centre is the biggest single investment in the hundred-year history of the family run business.

"In the future, the Viessmann Innovation Centre will be our breeding ground for innovations related to the energy transition and in the area of digitalisation," said Prof Martin Viessman, CEO of the Viessman Group. "It is where we are bundling development activities across the entire product engineering process, from the initial idea stage up to the start of production."

Meanwhile Chancellor Merkel said: "Today, you are demonstrating the great importance of research and development within your company. What began in a small workshop, is now a globally active group of companies; the development in those 100 years is something to admire." ■

(below) Sustainable energy technology specialist Viessmann's new €50m technological research and development centre in Allendorf, Germany.



Blowerproof airtight liquid membrane gets BBA certified

Blowerproof liquid air-tight membrane has been certified by the British Board of Agrément. Blowerproof has been used widely across Europe for many years as a proven and effective method of achieving high levels of airtightness in many different buildings, and on a wide range of substrates.

Simply brushed, roller applied or sprayed on, Blowerproof quickly forms a permanent, secure and continuous airtight seal across a range of leak-prone points: wall/floor/ceiling connections, fenestrations, and pipe connections including water, electricity, gas and data — all with no need for primers.

Applied as a blue, thick, fibre reinforced 'paint', Blowerproof Liquid Brush quickly cures to form a black, sealed membrane which is highly resistant to punctures. Blowerproof is also available in white, so it doesn't show through a plaster finish. Brushes rinse out under cold water, making Blowerproof Liquid Brush quick to deploy and pack away.

The roller applied version can be used directly on blockwork, brick, masonry and as a spray, which is ideal for larger areas such as walls and roofs. It can be directly spray-applied to the likes of mineral wool and sprayed set foams.

Free from both volatile organic compounds (VOCs) and harmful chemicals, Blowerproof is safe to use in high risk environments such as food, childcare and medical environments.

Commenting on the newly certified system, Jack Georgiou, BBA project manager said: "Blowerproof was subjected to a rigorous assessment by the BBA. The results of stringent tests were assessed including fatigue testing after accelerated ageing to verify the efficiency and durability of the airtight seal.

"Blowerproof performed in all aspects of the assessment and tests so we've certified it as being an effective way to improve the airtightness of buildings."

The brush applied version is being used to seal floor to wall junctions and ground floor service penetrations in Ireland's largest certified passive house development to date, Durkan Residential's 59 unit Silken Park scheme in west Dublin, which featured in issue 20 of Passive House Plus. The showhouse achieved a final airtightness test result of 0.2 ACH – one of the best permeability results ever published in Passive House Plus.

Meanwhile, leading passive house consultancy Encraft has specified Blowerproof on a number of its passive house projects. At St Johns Hospital in Lichfield 13 units have been tested to date, by Encraft's well-known airtightness expert Paul Jennings, and all have passed the passive house target. "When specified and installed correctly Blowerproof has absolutely delivered," said Jennings. "But it has also proven very helpful when dealing with failures on site. Normally we would have asked the team to remove and replace elements, with inevitable delays, but using Blowerproof meant that this wasn't necessary."

For more information see **www.blowerproof.co.uk.** ■

(above) Blowerproof Liquid Brush, used here to seal floor to wall junctions and building service penetrations.

(above) The award-winning Sandpath, the three-bed self build project that inspired the Kiss House concept. The CLT system comes with a broad range of exterior finishes such as brick slips or tiles, weathered copper bronze or white render with rounded edges, among others.

Kiss House launches "cutting edge" turnkey passive houses

Three leading firms operating in the sustainable building and passive house sectors have joined forces to launch Kiss House, a new concept in architect-designed, turnkey housing. Kiss House is available in two-bed, three-bed and four-bed options, all built to the passive house standard.

Kiss House brings together three industry leaders in a "marriage of award-winning architecture, award-winning project management, and the UK's foremost passive house certifier and training provider."

The team includes Oxford-based architect Adrian James, passive house project manager and cross laminated timber (CLT) specialist Trunk, and leading passive house certifier Warm.

"Award-winning design, delivery and quality assurance ensures Kiss House provides houses of the highest design standards, and of great aesthetic appeal," said Adrian James, one of the founders of Kiss House. "We offer a small range of semi-configurable, passive house certifiable houses, built with cross-laminated timber."

He continued: "Kiss House is an investment in one's quality of life, and by choosing Kiss House clients choose uncompromising quality and cutting edge design."

All Kiss House units will be built to the passive house standard, and thus be certifiable. "Passive house is the undisputed international gold standard in low energy building. A passive house is guaranteed to be extremely comfortable, healthy and low cost to run."

James said that Kiss houses are delivered with minimal environmental impact and the least possible aggravation for clients. "To ensure the procurement process is as simple as possible Kiss House operates a one-stop shop, the principle design is set and configurability gives a carefully created range of choices for the client to make their Kiss House their own."

In 2014, Adrian James Architects completed Sandpath, a three-bedroom self build which has gone on to become the inspiration for the Kiss House concept. Sandpath has won numerous architectural awards, including from RIBA and the Sunday Times British Home Awards.

"Sandpath generated a lot of interest and enquiries. I had previously worked with Mike Jacob at Trunk and they were looking to collaborate on a repeatable housing model so we decided to take advantage of the incredible interest in Sandpath, and thus Kiss House was born," Adrian James said.

Kiss stands for the well known acronym 'keep it simple stupid', and James said its key principles are beauty through simplicity; clean, well-proportioned spaces; a cuboid shape; care in the choice of materials, arrangement of openings and flow of space; the provision of a calming sanctuary; poise and lightness in the way the building sits on the ground; and a balance between being cutting edge and minimal but not alienating or austere.

He explained that CLT is unrivalled for strength, sustainability, energy performance and aesthetics. "It is so strong it can outperform concrete and steel. It comes from sustainably managed forests, where more trees are planted than are cut down. Panelised off-site construction is also one of the most efficient ways of building.

"It is inherently airtight, meaning no internal air leaking and no complicated airtight strategies. Our houses have very low running costs, are very comfortable, and make for happy and healthy occupants."

He added: "CLT is revered for its beauty and can be left exposed to provide crisp and clean internal surfaces."

Kiss House also offers the passive house standard at no extra cost. "Our exemplary quality standard is simply what we do," James said. "Kiss House is positioned to excel in both design and performance." Leading passive house certifiers Warm are part of the Kiss House team and are helping to develop a simple methodology for delivering cost effective passive housing.

Sandpath recently won a 2017 Best of Houzz Design Award for being one of the most visited projects on the 20 million subscriber strong website. The Kiss House team are now looking to harness this and are seeking customers for 2017, with the launch of their new website **www.kisshouse.co.uk**. They can be contacted at **iwantakiss@kisshouse.co.uk** and are **@KissLoveAffair** on Twitter. All 2017 customers will benefit from an extended handover period and a free smart home system. ■

Fabric First Institute wins Norfolk sustainability award

Low energy building training enterprise the Fabric First Institute, which is co-ordinated by passive house and energy consultancy Whole House Energy, picked up the award in the sustainability category at this year's Norfolk Constructing Excellence Awards, which were held on 21 April.

"Having opened our doors to our Fabric First Institute training courses at the end of last year with our partners Easton and Otley College, we are struggling to keep up with the demand for the 180 funded places, with only 40 left available at this stage," said Jackie Richards of Whole House Energy.

Architects Hamson Barron Smith won the overall award on the night for their Carrowbreck Meadow passive house scheme, which is profiled in this issue of Passive House Plus.

"That the evening overall was won by two sustainable / passive house projects gives a real boost and demonstrates clearly that the need for this type of development is really alive," said Richards.

The £200,000 funded year-long Fabric First training programme was developed in support of the £47m of passive house construction work committed to by Norwich City Council. "Requiring a highly skilled workforce, an enormous challenge and opportunity presented itself in the region which plans to see the development of hundreds of homes to the passive house standard over the next four years," Richards said.

There are currently two training packages available, a one-day course for contractors and subcontractors, and a one-week City and Guilds accredited level three module for students and learners still at college. These address topics such as insulation best practice, airtightness, thermal bridging, and ventilation with heat recovery.

The one-day training programme is delivered at Easton & Otley College at their Easton campus, where there is, as part of the project, a bespoke demonstration unit built to the passive house standard.

Main contractors who have undertaken the training to date include RG Carter, EN Suiter, J Smiths, Morgan Sindall, Dove Jeffrey, Pentaco and Fosters, along with various subcontractors and trades.

The Fabric First Institute is funded by Norfolk County Council, Suffolk local authorities and the Skills Funding Agency.

For more information see **www.wholehouseenergy.com/fabric-first-institute**. ■

(inset) The Fabric First Institute demonstration unit; (above) airtight taping exercise on launch night – November 2016. Photo by Simon Finlay.

New SIGA Majrex membrane awarded passive house cert

Pictured inset are (l-r) Passive House Institute founder Prof Dr Wolfgang Feist, SIGA head of business development Anselm Hoffmannn and Passive House Institute scientific advisor Søren Peper.

SIGA's brand new airtightness and vapour control membrane, Majrex, has become the first such product to achieve component certification from the Passive House Institute. Majrex is specifically designed to ensure one-directional drying of moisture in building elements, a particularly important function in timber-frame structures with non-breathable external layers such as flat roofs, for both new build and refurbishment.

"Wood constructions without rear ventilation of the external layer are critical in terms of building physics," read a statement from SIGA. "Structures frequently have no rear ventilation because of cost, or for aesthetic reasons. Moisture from drying screed and plaster as well as enclosed construction moisture can quickly become a problem."

SIGA said that it set itself the challenge of solving this problem and producing a safe vapour control layer for such situations. "SIGA took a look at nature and asked: Why is it that the cactus can survive extreme climatic conditions such as heat and drought? The secret: moisture transport in one direction only. How can we use this ingenious principle for our new vapour control layer?"

After several years of research and development SIGA developed its Hygrobrid technology, which provides one-directional moisture transport. SIGA Majrex, which incorporates Hygrobrid technology, ensures better safety for wood constructions even when moisture levels are high — such as after screed has been laid, when walls are freshly plastered or when the structure is subjected to extreme moisture during use.

Moisture development within the structure is minimised and moisture transport out of the structure is maximised thanks to Hygrobrid technology. Majrex has been rigorously tested by the Technical University of Dresden. "The measurements prove that SIGA Majrex with Hygrobrid technology significantly reduces moisture development in the structure compared with conventional variable vapour control layers," according to SIGA. Majrex is suitable for many new build construction types and for retrofit projects. ■

Velox launches timber-cement ICF for passive market

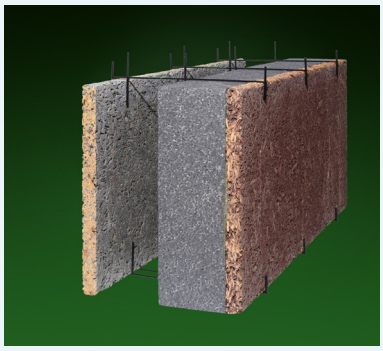
Velox has launched its panellised woodcrete ICF system to the UK market to provide an ecological, scalable, rapid-build solution to meet the growing demand for passive house and low energy buildings. The innovative system is designed to provide extra-fast construction on site, and to deliver U-values as low as 0.09 W/m²K and airtightness that averages 0.6 air changes per hour as standard.

Velox told Passive House Plus that its boards are made from 90% woodchip that is mixed with cement and water. The company was founded in 1956 in Austria, when brothers Franz and Peter Steiner sought new ways to use woodchip waste from local sawmills.

The Velox system provides a comprehensive framework that can be used to construct external walls, internal walls, ceiling elements and shell wreaths. It is capable of delivering buildings up to 21 storeys high, and can support floor spans of up to 12 metres. The pre-manufactured system can be used to build the walls and floors of a typical house in just one week once on site.

For architects and specifiers seeking demanding U-values, the Velox WS-EPS board features an integrated polystyrene backing on the woodcrete board, and is used for the outer layer of the ICF system on projects seeking passive house levels of thermal performance.

The Velox system has been used to deliver over 50,000 houses and apartments around the world to date. It is certified by LABC under RD354, and warrantied by the LABC, NHBC, CRL and others. For more information see **www.velox-systems.co.uk**. ■



(above) The Velox woodcrete ICF system can deliver U-values as low as 0.09.

Schueco launches enhanced slimline facade system

Leading sustainable building envelope specialist Schueco UK has announced new developments to its ultra-slimline FWS 35 PD panorama design facade system. Shown at BAU 2017, the enhanced system delivers "even greater visual elegance and transparency, the option of sun-shading and two levels of burglar resistance".

A major innovation is the introduction of an all-glass corner solution which obviates the need for intrusive profiles or pull-push rods by transferring the glass load directly to the adjacent mullions. The result is wider unobstructed views and greater transparency from inside, and a sleek contemporary look outside.

With passive house certification for the top Schueco FWS 35 PD.SI version, the range offers thermal insulation levels as low as 0.79 W/m²K and can accommodate double-and triple-glazed units from 22mm to 50mm thickness. Where ventilation is required, the new Schueco FWS 35 PD facade can incorporate Schueco AWS 114 opening window units, operated either manually or mechanically.

Also seen at BAU for the first time was the company's new concept window, Schueco AWS 75 PD.SI, an ultra-slim turn-tilt window which can be integrated into the Schueco FWS 35 PD facade.

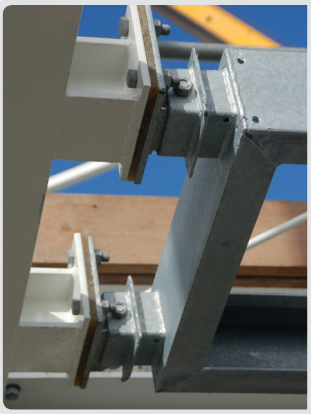
Recognising the importance of solar shading for large glazed areas, the Schueco FWS 35 PD facade offers two newly introduced methods of attachment by means of bolts or brackets. Discrete connection components are able to accommodate a wide variety of shading units despite the Schueco FWS 35 PD facade's very slim profiles. This extends the system's design flexibility in line with other Schueco facade systems.

Reflecting the growing importance of security, the new Schueco FWS 35 PD facade offers three levels of security – standard or resistance classes 2 and 3 of EN 1627, the latter incorporating P4A and P6B security glass. Because the components that help to achieve this are fully concealed, the appearance of the facade is unaffected.

For full details of the enhanced Schueco FWS 35 PD facade system see **www.schueco.com**. ■

(above) Schueco's FWS 35 PD includes an all-glass corner solution which obviates the need for intrusive profiles or pull-push rods by transferring the glass load directly to the adjacent mullions.

Specify carefully to eliminate thermal bridges safely - Farrat



There are few standard construction details where thermal breaks are incorporated because of the large variety of materials and systems forming the building envelope. This makes appropriate analysis, detailing and specification crucial at such junctions, according to market specialists Farrat.

Building components that penetrate the insulated envelope will produce a thermal bridge, resulting in significant energy loss if not addressed. While energy loss is important, there is also a higher chance that this could lead to condensation with resulting damage to the building's fabric and mould growth.

According to Farrat, structural thermal break plates are a simple and efficient way of preventing thermal bridging and meeting the requirements of the building regulations.

"The trick is to choose a thermal break plate solution that is both simple and effective," the company says. "Structural connections incorporating thermal break plates need to perform well both thermally and structurally and of course there will be a compromise to satisfy both requirements. It is absolutely vital that the thermal break material is fit for purpose."

Whilst compressive strength is an obvious requirement for thermal break plates, the potential for creep under constant load may lead to significant serviceability issues further down the line when the contractor has long disappeared. It is therefore important that the material properties required for both thermal and structural performance have been independently certified, the company said.

The structural performance of connections can be seriously impaired if inappropriate materials are incorporated or if the connection design does not properly consider the inclusion of the thermal break material.

Farrat is a global specialist in the design and manufacture of vibration control, thermal isolation and precision levelling solutions for the construction, industrial and energy sector. ■

(above) Specialist structural thermal breaks from Farrat are designed to minimise heat loss while protecting the building's structural integrity.

Ecological take double honours at SEAI Energy Show

Ecological Building Systems' Diasen Diathonite Evolution cork lime thermal plaster was awarded with the best energy efficient product prize at this year's SEAI Energy Show, held in Dublin on 5 and 6 April.

"It was incredible to see that among many technical products ranging from high performance solar panels, heat pumps, combined heat and power and other impressive technical solutions, an ancient building material, lime and cork, used as far back as the Roman times, won the best energy efficient product award in 2017," said Niall Crosson, senior engineer with Ecological Building Systems.

Diathonite Evolution thermal plaster combines the breathable properties of lime with the unique thermal properties of cork, clay and diatomaceous earth, and is suitable for use on the retrofit of existing buildings as well as in new buildings. With a thermal conductivity of only 0.045W/mK, just 30mm of Diathonite can reduce the U-value for a solid wall from 2.5W/m²K to 0.8W/m²K, while allowing the wall to breathe and minimising the risk of long-term moisture or mould issues.

"It was rewarding to see that SEAI recognised the valuable contribution and technical benefits traditional natural insulation materials can make to aid in the delivery of robust and effective retrofitting of the Irish housing stock," Crosson added.

Meanwhile Ecological's new low energy retrofit course was highly commended in the best service provider category. There have been full bookings at each course so far, Ecological have reported, with attendees coming from all over Ireland and the UK.

Crosson added: "It is clear that there is a critical need to increase training and education to ensure a retrofit or new building is executed to a high standard and nZEB is attained, with appropriate materials to prevent having to 'retrofit our retrofits' and new builds in the future. With so many training courses now available, there has never been a better time to upskill."

Ecological distribute the range of Diasen cork lime thermal plasters to Ireland and the UK. For more information regarding Ecological's training courses or for samples and information concerning Diasen Diathonite Evolution cork lime thermal plaster see **www.ecologicalbuildingsystems.com**. ■

(below) Pictured are (l-r) CIBSE Ireland chairman David Doherty, SEAI's head of energy demand management Majella Kelleher and Ecological's Niall Crosson.

Eksalta launches sash lookalike low energy window

(above) Eksalta's VictorianSASH low energy windows and Ferro KlassikPlus door – in this case designed to look like a Victorian door – at a Constructive Individuals-designed retrofit in York.

Eksalta Sustainable Retrofit Ltd, supplier of high performance engineered timber windows and doors, has launched its new sash lookalike VictorianSASH window. The VictorianSASH triple-glazed wooden window has been designed to replace traditional sliding box sash windows. This sash window replacement delivers the authentic appearance, heritage and elegance of the classic sliding sash window, but with excellent airtightness and thermal performance, according to Eksalta.

The window, which features a fixed top sash and tilt & turn bottom window sash, combines the latest technology, high security and performance with the period features of a traditional sash timber window.

Eskalta say that VictorianSASH is an ideal solution for Enerphit retrofit projects, with an overall window U-value of 0.92 for a standard size, and a glazing U-value of 0.526. The product is designed for low energy retrofit and Enerphit projects in historic buildings, where designers are seeking passive performance windows with a traditional sash appearance.

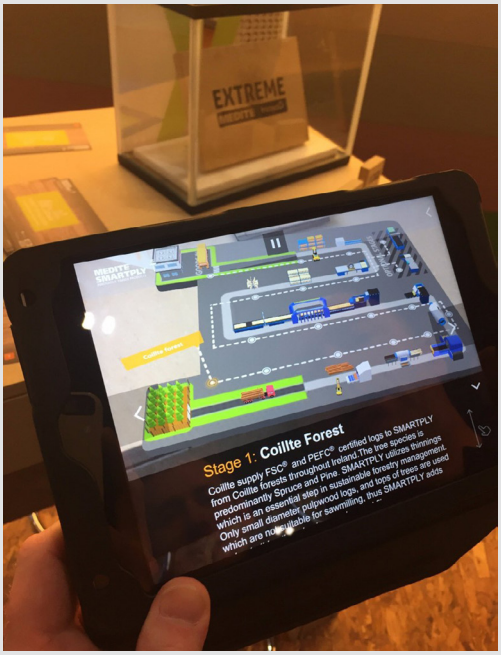
The windows were recently installed on the renovation of an historic gate lodge in a conservation area of York, retrofitted by architect Phil Bixby of the practice Constructive Individuals and building contractor Steve Kent of Kent Building Developments.

"These windows enabled us to maintain the appearance of this fine old house while carrying out a pragmatic retrofit within a limited budget, alongside an ambitious extension to give the clients more living space," said Bixby. "The cost of these windows was a pleasant surprise to the builder and the appearance was a pleasant surprise to the planning officer."

Meanwhile the homeowners said: "When the windows arrived, we were amazed by both their appearance and the workmanship. We were delighted! No one seeing the house from the front can even tell they are modern windows, but we can, as the house is now warm and draught-free."

For more information on VictorianSASH windows see **www.victorian-sash.co.uk**. Eksalta also supplied the high performance Ferro KlassikPlus door for the project, which in this case was specially designed by Eksalta to look like a traditional Victorian front door. ■

Medite Smartply launches augmented reality app



Medite Smartply, producers of innovative timber panel products, has launched a new augmented reality app for its Smartply product range.

The Smartply AR app, which is live on iOS and Android, features a product data tool providing a comprehensive breakdown of the entire Smartply product range. The tool includes detailed information that is broken down into easy to digest sections, making it ideal for reading on the go, and a useful companion when selling, specifying or using Smartply products.

The app also includes a forest-to-factory feature, a 3D augmented reality, step-by-step walk through the company's manufacturing process. The visualisation takes the user all the way through the supply chain, from the sourcing of raw material from the company owned forests, right through to the products being loaded onto a lorry and delivered to the customer.

"Our new Smartply manufacturing facility and our sustainable supply chain are things we are extremely proud of," says Stuart Devoil, the company's head of marketing. "It's great for our audience to now be able to see exactly how much goes into producing our products to such a high standard. Seeing the procedure so clearly documented provides the chance to see exactly how we operate and really brings the process to life."

"The app also doubles as a handy Smartply pocket product library on your phone that shows users the benefits, features and proper handling instructions for the entire Smartply product range."

The app is available to download from the Apple App Store and Google Play. Simply search for **Smartply AR.** ■

Back up is key for facade systems - SPSenvirowall

The Mansell Ford Farm development in Cornwall was built to the passive house standard, and features the RendaClad external insulation system from SPSenvirowall.

Leading façade systems supplier SPSenvirowall has advised of the importance of making sure your external wall insulation or other facade system has the proper certification and technical back-up to ensure it remains durable and performs over the lifetime of your building.

"SPSenvirowall have been supplying high quality façade systems for over 20 years backed by extensive accreditation, guarantees and exceptional service including on and offsite technical support," said Mitch Gee of SPSenvirowall.

"Whether you are considering external wall insulation systems, seamless rendered rain screen cladding systems, high performance glass or stone cladding, SPSenvirowall will help design and supply your façade system. These products are highly suited to passive house design enabling high levels of wall insulation without compromising on the aesthetics of the design."

External wall insulation products supplied by SPSenvirowall include cost effective EPS as well as mineral wool and phenolic insulation. The company's rendered products can be supplied in any one of 400 standard colours.

"Our range of renders include high performance silicone renders that have exceptional water repellence qualities combined with a high degree of vapour permeability. We will provide U-value and condensation risk calculations free of charge as well as project-specific specifications and detailing," he said.

"Our range of glass of rain screen cladding products contain 16 contemporary colours. We are also able to offer a range of real stone finishes at a fraction of the cost of standard stone cladding."

Further information can be found at www.spsenvirowall.co.uk, by contacting one of the company's technical consultants or calling into one of its depots, which are based around the country. ■

Swegon launches new WISE demand controlled ventilation system

Swegon has launched its new generation WISE demand controlled ventilation system, which "represents over 15 years' experience and the latest pioneering technology in demand controlled ventilation".

According to Swegon, demand controlled ventilation can save up to 80% of the fan energy and 40% of the cooling and heating energy in a building, by supplying air, cooling and heating in just the right amounts, and at the right time and to the right places. Swegon's new WISE system is able to do this without sacrificing any indoor climate comfort, the company said.

The new generation WISE system has been developed using "cutting edge development work and experience gained from hundreds of installations". It is designed to be easy to install, flexible and user friendly. Software such as Swegon ESBO (Early Stage Building Optimisation), and the product selection software IC Design, provide decision making support.

Dene Kent, head of ventilation at Swegon, explained: "The modern software we have created makes complex issues simple to handle, by starting from the customer's needs, suggesting products and providing visual support. It's easy to create a great indoor climate in each room."

To simplify the later stages of the building process, the system is based on the latest technology for wireless communication. A patented radio solution makes the WISE products, such as dampers and diffusers, communicate via integrated radio nodes. This means significant cost savings thanks to reduced cabling and it eliminates the risk of misconnections. "Taking the step from wired to wireless technology is a major leap, helping us build a system that is even more reliable and easier to install," Kent added.

To top off the new WISE system, the web-based Super WISE user interface has been completely remodelled. With maximum visual overview and simple handling of system settings, Kent said Super WISE is designed to be "exceptionally easy to work with".

For more information visit **www.swegon.co.uk.** ■

(above) Some of the broad range of component options that are included in Swegon's WISE demand controlled ventilation systems.

PH+ **HELP DESK**

WHAT EXACTLY IS AN nZEB ANYWAY?

The quest for clarity

Unclear definitions for nearly zero energy buildings are confusing the building industry and distracting from delivering better buildings, says architect and DIT lecturer Simon McGuinness.

I have been struggling to define nearly zero energy building – nZEB – since 2010. This is a serious problem. It takes up to ten years to bed down building regulations and achieve buy-in from all contributors to the notoriously long supply chains involved in the construction industry. Everyone — product manufacturers, suppliers, specifiers, contractors and the trades — needs absolute clarity on the nZEB target.

Yet the current state of affairs is more a legacy of how we in these islands have traditionally structured our building regulations, than any reflection on EU policy. The subdivision between residential and non-residential, new build and retrofit, and historic building and postwar buildings has created levels of complexity for the practitioner. It's possible to have five different wall U-value targets in a mixed development incorporating renovation works, extension and new build elements.

Unbelievably, there could be more, if any part of the development is to be occupied by a state agency after 2018, the date set in the Energy Performance of Buildings Directive (EPBD) by which all public buildings must meet the nZEB standard. And that's before we consider the well-meaning input of devolved assemblies (Scotland, Wales, Northern Ireland) into the confusion. This regulatory complexity adds to the cost of construction in these Islands, without obvious benefit.

By comparison, the EU is something of a paragon of virtue. The European Commission wants to ensure that, after 2020 has passed, virtually all buildings will achieve the nZEB performance standard, regardless of their age or use. This laudable simplicity is reflected in its 2016 recommendation to member states (EU 2016/1318), which says:

The framework definition of nZEB in the EPBD does not differentiate between new and existing buildings. Having such differentiation may be misleading towards consumers, as would be the case if there were separate Energy Performance Certification ratings for new and for existing buildings.

"'Refurbishment into nZEB' therefore means a refurbishment of a magnitude that allows the energy performance requirements of a nZEB level to be met."

To further eliminate the potential for doubt around interpretation, the commission has defined actual kWh/m^{2}y targets for nZEB, in our climate zone, for two sample building types: 40-55 kWh/(m^{2}y) of net primary energy for offices, and 15-30 kWh/(m^{2}y) for new single-family dwellings.

Unfortunately, neither of these target figures appear in any existing, or proposed, building regulation in the UK, or Ireland, even those applicable to buildings delivered after the 2020 transition.

I accept that we are in a transitional, even liminal, phase in the development of our regulations towards nZEB. However, in over 30 years of practice, I've never known a period where there was such a lack of clarity on the long-term trajectory of regulation in the construction industry.

How have we arrived at this juncture? The complexity of 28 member states in different climate zones and with very different regulatory traditions explains some of it, but the "cost optimal" definition and methodology embodied in the EPBD has proved to be something of a flag of convenience for all sorts of natural procrastinators, climate change deniers and adherents to political expediency right across Europe.

> "In over 30 years of practice, I have never known a period where there was such a lack of clarity on the long-term trajectory of regulation in the construction industry.

In new regulations just issued, the Irish government persists in defining nZEB for office buildings at up to 338 kWh/m^{2}y, over six times the commission's maximum target figure of 55 kWh/m^{2}y. We are also promised future regulations in the UK and Ireland which will set nZEB for new housing at around 45kWh/m^{2}y, some 50% higher than the commission's maximum level. (ed. - the Dept of Housing has suggested differences in accounting for renewable energy generation may be reducing the commission's target – an argument which demands scrutiny).

Allowing national governments to take limited experience of building to ultra-low energy standards, and project possible costs for a range of notional measures applied to notional building types, is no substitute for the lived experience of professionals delivering real, occupied and monitored building projects consistently to the nZEB standard, or better. Such experience is worth feeding into the national cost optimal planning models from which to generate viable nZEB targets. These will finally close the gap with the commission's well-grounded ambition.

The Netherlands experience with cost optimality is instructive. There, the first nZEB public housing retrofit cost over €130,000, took many weeks to build and required lots of adjustment to deliver the promised energy savings. Hundreds of retrofits later, the nZEB standard is being delivered routinely in the Netherlands for €65,000 per house in just three days. And their industrialised methods are being exported to other countries.

The results are so good that financial institutions are carrying the risk and making a tidy return on the investment from the energy savings. It's hardly surprising that the cost optimal target of the Energiesprong programme is net zero primary energy, or what they call "zero on the clock", significantly better than the commission's 2016 recommendation. This is the difference between notional and actual cost optimality calculation, and underpins the ambition of the commission's recommendation.

If new build nZEB targets aren't sufficiently at variance with the commission's recommendations, the proposals currently offered for renovation of existing offices and houses, as enshrined in current or proposed regulation, are even more divergent from the commission's vision. It's difficult to regard them as definable energy performance targets in any real sense.

How we got to this point is of little relevance, what matters is that we rapidly move to defining some hard performance figures in coherent, integrated and future-proofed national regulation, so we can begin the arduous task of upskilling and re-tooling the industry. Meanwhile, my advice to construction professionals and product suppliers alike is to regard national nZEB targets as just another interim stage in the development of nZEB regulations. Professionals should seek to upskill, and suppliers to re-tool, to deliver on the commission's targets, rather than any interim national target. ■

HAVE A QUESTION YOU WANT TO PUT TO THE HELP DESK?

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Please note that personal correspondence cannot be entered into.

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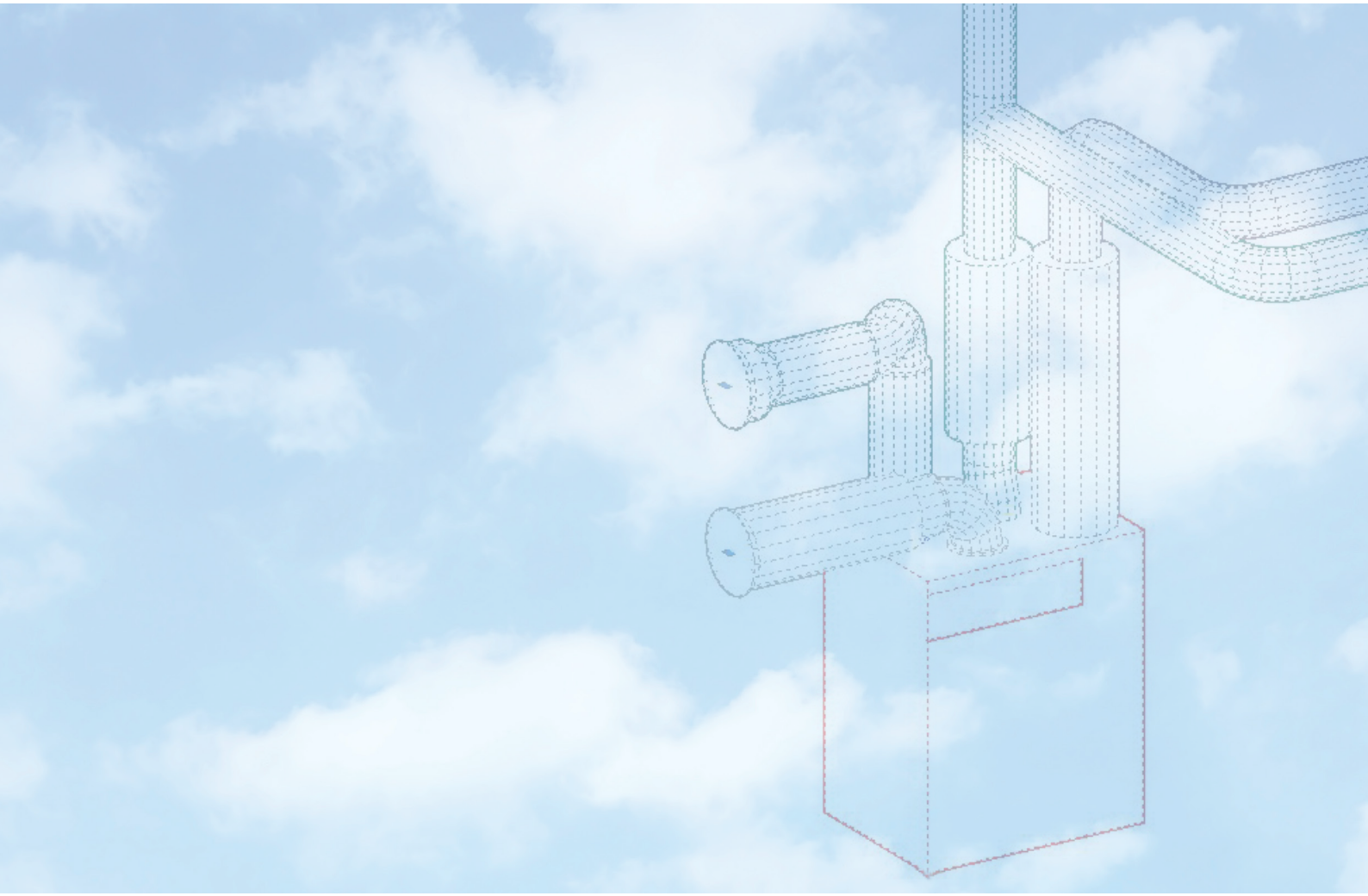

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